Department of Defense
Unique Identification (UID) Implementation Plan

for

DoD Maintenance Depots

May 2005

Prepared by the Office of the Secretary of Defense
Materiel Readiness and Maintenance Policy

ADUSD(L&MR)MR&MP

UID Implementation Plan for DoD Maintenance Depots

MAY, 2005

Executive Summary

In response to GAO Audit Findings critical of the Department's ability to physically and financially account for its spare and repair parts, and in support of the ongoing compliance requirements of the Chief Financial Officers' Act, OSD undertook to improve its ability to account for the Department's tangible items. The DoD vision for unique item identification is to implement policy, regulations, and supporting processes that enable the Services to uniquely identify all significant tangible items in their inventories. This initiative is considered a strategic business imperative for the Department of Defense.

On 29 July 2003, the Acting Under Secretary of Defense (Acquisition, Technology and Logistics) signed a policy memorandum entitled "Policy for Unique Identification (UID) of Tangible Items – New Equipment, Major Modifications, and Reprocurements of Equipment and Spares". This Policy made UID a mandatory DoD requirement on all new equipment and materiel delivered pursuant to solicitations issued on or after January 1, 2004. USD(AT&L) issued verbal guidance that tangible assets manufactured by DoD's organic depots were to be considered "new" items which fall under UID marking policy, beginning 1 January, 2005. An item is considered "significant", and will be uniquely identified if: (1) the acquisition cost (manufacturing cost for DoD depots) is $5,000 or more, (2) it is either a serially managed, mission essential or controlled inventory piece of equipment, or a reparable item, or a consumable item or materiel where permanent identification is required, (3) it is a component of a delivered item, if the Program Manager has determined that unique identification is required, or (4) a UID or a DoD-recognized UID equivalent is available.

In setting forth a UID policy, the following strategic outcomes were defined:

- Data integration across Department, Government, and Industry systems as envisioned by the DoD Business Enterprise Architecture
- Improved item management and accountability
- Improved asset visibility and life-cycle management

- Clean audit opinions on the property, plant, and equipment and operating materials and supplies portions of DoD financial statements

In a major policy update dated 23 December, 2004, USD(AT&L) issued a Memorandum entitled "Policy for Unique Identification (UID) of Tangible Personal Property Legacy Items in Inventory and Operational Use, Including Government Furnished Property (GFP)"[1] . This update extended the parts marking and data management requirements, previously applied only to newly manufactured items, to all significant items currently in the DoD inventory.[2]

The policy update has profound implications for the DoD depots, both organic and commercial, as well as for the entirety of the DoD maintenance enterprise. Since parts will not normally be removed from service for the sole purpose of UID marking, the majority of legacy marking will take place in conjunction with a maintenance or modification action ("opportunistic marking"). This increases by two or three orders of magnitude the number of UID actions our depots must be prepared to manage.

Legacy UID capability will be established at the depots in phases. USD(AT&L)'s December 2004 policy memo states: "The Military Departments should plan on establishing initial depot operating capabilities for (selected) legacy items by July 2005, at those depot facilities currently involved with UID for depot manufactured items[3]. Full Operating Capability (FOC) at all organic depots will be put in place not later than FY 2007." IOC dates for all organic depots other than the three pilot depots will be determined prior to November, 2005 and published in the December, 2005 DUSD(L&MR) "*Full Operating Capability UID CONOPS for DoD Maintenance*".

Program Managers are required to plan for UID implementation for the legacy items over which they have cognizance. Program plans must be submitted by January, 2006 (June 2005 for ACAT 1D Programs).

A summary of all the major milestones identified in the December, 2004 USD(AT&L) UID policy memorandum is in Figure ES-1.[4]

[1] "Personal Property" in this context is an accounting term which refers to all tangible items that are not "real property" (real estate, buildings, facilities, etc.).

[2] The 23 December 2004 policy update also formalized the requirement that DoD Depots mark newly manufactured items.

[3] DoD's three pilot depots for UID are NADEP Cherry Point, Letterkenny Army Depot and Ogden Air Logistics Center.

[4] On May 12, 2005, USD(ATL) issued a new *Policy Update for Item Unique Identification of Tangible Personal Property, Including Government Property in the Possession of Contractors.* The updated policy does not change any of the depot planning requirements identified in this Plan. Features of the update of interest to the DoD depot community, in particular policy supporting SIM enabled by UID, will be incorporated in the next revision to this Plan.

Milestone	Responsibility	Q1 FY05	Q2 FY05	Q3 FY05	Q4 FY05	FY06	FY07	FY08	FY09	FY10	FY11
Quality Assurance Plan for UID	DCMA		Jan-05								
OSD UID Budget Guidance to Components	OSD AT&L			Apr-05							
Legacy UID Implementation Plan for DoD Depots	OSD L&MR			May-05							
UID Program Plans (ACAT 1D Programs)	Pgm Mgr			Jun-05							
IOC Legacy Marking Capability at Pilot Organic Depots	Military Departments				Jul-05						
FOC UID CONOPS for DoD Maintenance	OSD L&MR					Dec-05					
UID Program Plans (All Programs)	Pgm Mgr/Item Mgr					Jan-06					
All GFE Meets UID Policy Requirements	Pgm Mgr/Item Mgr					Jan-06					
All Existing Serialized Assets Entered in UID Registry	Pgm Mgr/Item Mgr						Sep-07				
FOC Legacy Marking Capability at All Organic Depots	Military Departments						Sep-07				
Complete UID Marking of All Legacy Items	Pgm Mgr/Item Mgr										Dec-10

Figure ES-1.

This *Legacy UID Implementation Plan for DoD Depots* highlights the requirements which the DoD depots must meet, suggests preferred ways of meeting these requirements, and discusses the roles and responsibilities of the key Stakeholders associated with successful depot UID implementation. Specific issues addressed include:

- OSD UID policy flow-down to the Depots
- Depot UID planning and resourcing
- Organization and function of the joint Depot/Program Management Office Integrated Project Team (IPT)
- Identifying what items require UID marking
- Determining where and how to mark items
- Minimum attributes and capabilities of the Depot UID Automated Information System (AIS)
- Integrating parts marking into the Depot maintenance, repair and overhaul (MRO) production process
- Marking items and verifying the quality of the mark
- Populating the UID Registry and other decision support system (DSS) data bases
- Tracking marked parts -- the bridge to serialized item management (SIM)

Contents

Appendixes

Chapter 1 Introduction

PURPOSE AND VISION FOR UID

CFO Act, FASAB Standards and GAO Reports

The Unique Identification (UID) Program began as one of the Department of Defense's solutions for addressing compliance problems associated with the Chief Financial Officers Act of 1990. The CFO Act, and subsequent acts such as the Government Performance and Results Act of 1993, Government Reform Act of 1994 and the Federal Financial Management Improvement Act of 1996 were designed, among other things, to promote accountability and reduce costs. In October 2002, DoD identified the need for improved tracking and valuation of plant, property and equipment (PP&E) to address Congress' concerns, and to comply with recent Federal Accounting Standards Advisory Board (FASAB) requirements. Improvements in asset accounting were critical to the Department's goal of having a "clean" PP&E audit opinion by FY 2007.

Additional pressure was being applied by the General Accounting Office (now Government Accountability Office). In a March 2002 Audit Report[5], GAO found that "...the federal government lacks complete and reliable information for reporting inventory and other property and equipment, and can not determine that all assets are reported, verify the existence of inventory, or substantiate the amount of reported inventory and property."[6]

OSD UID Program

In response to the GAO Audit Findings and the ongoing compliance requirements of the Chief Financial Officers' Act, OSD undertook to improve its ability to account for the Department's tangible items. The DoD vision for unique item identification is to implement policy, regulations, and supporting processes that enable the Services to uniquely identify all significant tangible items in their inventories. For the reasons noted above, this initiative is considered a strategic business imperative for the Department of Defense. The policy relies to the maximum extent practical on commercial item markings and does not impose unique government

[5] Executive Guide, Best Practices in Achieving Consistent, Accurate Physical Counts of Inventory and Related Property, GAO-02-447G

[6] GAO-02-447G, p.6

data requirements on industry[7]. To that end, uniquely identifying tangible items will facilitate item tracking in DoD business systems and provide reliable and accurate technical and financial data for financial accountability and asset management purposes.

On 29 July 2003, the Acting Under Secretary of Defense (Acquisition, Technology and Logistics) signed the "Policy for Unique Identification (UID) of Tangible Items – New Equipment, Major Modifications, and Reprocurements of Equipment and Spares" (see Appendix A).

This Policy made UID a mandatory DoD requirement on all new equipment and materiel delivered pursuant to solicitations issued on or after January 1, 2004. USD(AT&L) issued verbal guidance that tangible assets manufactured by DoD's organic depots were to be considered "new" items which fall under this UID marking policy, effective 1 January, 2005. An item is considered "significant", and will be uniquely identified if: (1) the acquisition cost (manufacturing cost for DoD depots) is $5,000 or more, (2) it is either a serially managed, mission essential or controlled inventory piece of equipment, or a reparable item, or a consumable item or materiel where permanent identification is required, (3) it is a component of a delivered item, if the Program Manager has determined that unique identification is required, or (4) a UID or a DoD-recognized UID equivalent is available.

In setting forth a UID policy, the following strategic outcomes were defined:

- Data integration across Department, Government, and Industry systems as envisioned by the DoD Business Enterprise Architecture
- Improved item management and accountability
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In a major policy update dated 23 December, 2004, USD(AT&L) issued a Memorandum entitled "Policy for Unique Identification (UID) of Tangible Personal Property Legacy Items in Inventory and Operational Use, Including Government Furnished Property (GFP)"[8] (see Appendix C). This update extended the parts marking and data management requirements, previously applied only to

[7] It should be noted that, by allowing industry to mark tangible items in any UID "approved" fashion, DoD is accepting a potentially significant burden on its information systems. Each logistics enterprise (procurement, transportation, supply, maintenance and sustaining engineering) will be required to have the capability to read and interrogate all acceptable marking formats in order to transact data to and from the UID Registry, and other data bases.

[8] "Personal Property" in this context is an accounting term which refers to all tangible items that are not "real property" (real estate, buildings, facilities, etc.).

newly manufactured items, to all significant items currently in the DoD inventory.[9]

The policy update has profound implications for the DoD depots, both organic and commercial, as well as for the entirety of the DoD maintenance enterprise. Since parts will not normally be removed from service for the sole purpose of UID marking, the majority of legacy marking will take place in conjunction with a maintenance or modification action ("opportunistic marking"). This increases by two or three orders of magnitude the number of parts our depots must be prepared to manage.

Program Managers are required to plan for and implement UID for the legacy items over which they have cognizance. Program plans must be submitted by January, 2006 (June 2005 for ACAT 1D Programs). A UID Implementation Plan for DoD's organic depots is an important input to these plans, and depot parts marking capability establishment is on the critical path to legacy UID success.[10]

The UII, and UID Data

The UID mark, called the Unique Item Identifier (UII), will eventually be permanently applied to the majority of tangible items in the DoD inventory. The UII is an alpha-numeric tag consisting of a few characters. Current policy requires that the data be encoded in a machine-readable Two Dimensional (2D) Bar Code (Figure 1-1.).

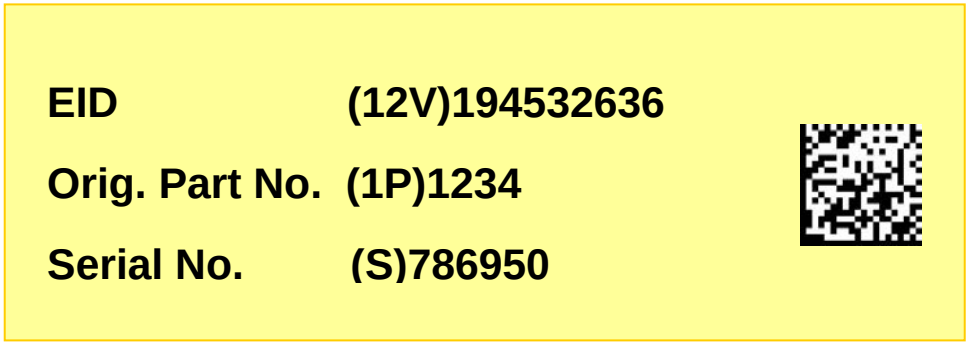

Figure 1-1.

[9] The 23 December 2004 policy update also formalized the requirement that DoD Depots mark newly manufactured items.

[10] On May 12, 2005, USD(ATL) issued a new Policy Update for Item Unique Identification of Tangible Personal Property, Including Government Property in the Possession of Contractors. The new policy does not change any of the depot planning requirements identified in this Plan. Features of the new policy of interest to the DoD depot community, in particular policy supporting UID and SIM, will be incorporated in the next revision to this Plan.

Like an automobile license plate, or a Social Security Number, someone reading the UII itself will not be able to learn much, directly, about the item. Unlike Radio Frequency Identification Technology (RFID), where all of the data meant to be accessed is self-contained - recorded within the device's memory - virtually all UID data is stored off line. Permanent data associated with the item which is transacted to the UID Registry at the time the item is marked is considered the item's "birth record". Most of this baseline data is static; it is never changed during the life of the marked item.[11]

In order to capture a baseline UID item pedigree, the following core UID data elements are required (data elements are described in greater detail later in this Plan; data elements that are optional for legacy items are indicated with an *):

1. UID Type
2. Concatenated Unique Item Identifier

Based on the UID type, one or more of the following elements may be required:

3. Issuing Agency Code
4. Enterprise Identification Number
5. Original part, lot or batch number
6. Current Part Number
7. Serial Number
8. Item Description
9. Unit of Measure

In addition to these elements, the following acquisition data elements are required:

10. Contractor's CAGE code or DUNS number*
11. Contract Number*
12. CLIN/SLIN/ELIN*

[11] There is ongoing debate about the preferred location for "birth record" data that may need to be periodically updated. The initial information which never changes will most certainly reside in the UID Registry. The information which likely will change as the item "ages" (physical location; item value [possibly]) may be centrally stored or may be distributed among a number of different, *but completely integrated*, Service data bases. If the data is distributed, the Registry will be the master "pointer" to current data; the Registry must, therefore, be updated whenever the current data is relocated so it is always able to "point" to the right place.

13. Acquisition cost*

14. Acceptance Location Code*

15. Shipment/Acceptance Date*

16. Ship To Code*

In a UID policy update memorandum issued on 3 September, 2004 (Attachment B), USD(AT&L) identified the following five additional data elements which will be required to support overseas procurements, identification of legacy items, use of virtual UIDs, and tracking of Government Furnished Property (GFP): 1. Action Code, 2. Currency Code, 3. Current Part Number with effective date, 4. GFP Flag (Y/N) with effective date, and 5. Current Marking Type with effective date.

At the present time, it is envisioned that the UID Registry will be a Joint, DoD-level data base maintained by DLA.

APPLICATION OF UID TECHNOLOGY

There are four related, but independent, applications of UID technology.

Improving Inventory Management and Cost Accounting Capabilities for New Items

The first application uses the technology to account for and track new items purchased by the Department. The UID Program was initiated in response to a requirement for improved inventory control of DoD materiel, and for improved financial accounting and reporting of that materiel. This includes automating the materiel acceptance and receipt function currently performed using the DD-250. Initial UID policy required the DoD Acquisition Community (Service Acquisition Executives, PEOs, PMs, Commodity Managers, Item Managers, etc.) to insert contract clauses making it the manufacturer's responsibility to apply a (standardized) UID mark to the materiel he intends to sell to the DoD[12]. It is also the manufacturer's responsibility to compile and record required asset information specific to each part he makes so the data (the item's "birth record") may be entered into the UID Registry and other data bases. With the exception of depot manufactured items, there are currently no significant maintainer responsibilities associated with this application.

[12] The Defense Federal Acquisition Regulation Supplement (DFARS) governs Defense contract procurement. Specifics on UID governance are found in DFARS Clause 252.211-7003, which requires DoD contracting officers to include the clause in all solicitations and define items that need identification and valuation.

Improving Inventory Management and Cost Accounting Capabilities for Legacy Items

The second application of UID technology is to enable improved material asset tracking and cost accounting of legacy items currently in the DoD inventory. DoD owns millions of individual tangible personal property items that will need UID marks applied and item data compiled for posting to the static UID Registry and the multiple dynamic Service inventory and financial accounting data bases. While these legacy marking efforts won't necessarily be the sole responsibility of the DoD maintenance community, it is likely that most legacy marking will be done in conjunction with a maintenance action ("opportunistic marking"). It is, therefore, critically important that DoD maintainers be actively involved with the equipment Program Managers (PMs) assigned responsibility for prioritizing and planning legacy UID. Cognizant PM plans for legacy UID must address funding issues (who will pay for the equipment, labor and material needed to mark millions of legacy items?), engineering issues (who will tell the maintainers where to place UID marks on legacy items and approve the marking technology to be used?), and process issues (where will DoD maintainers get the item inventory and accounting information to be associated with the UID mark and posted to the UID Registry?). Initial OSD policy guidance to Service Acquisition Executives regarding legacy UID is was issued on 3 September, 2004 (Appendix B), and a comprehensive legacy policy update was released on 23 December, 2004 (Appendix C).

Figure 1-2. depicts a notional network of interconnected computers and data bases designed to improve the Department's ability to capture, store, retrieve and update information about the value and physical location of its inventory of personal property items. The key enabler is the UII, which both ensures the uniqueness of the relationship between a tangible asset and the asset's pedigree data, and contributes significantly to data accuracy by automating the transaction process. A supporting enabler is RFID which will be used to track the physical movement of the packages which contain UID items.

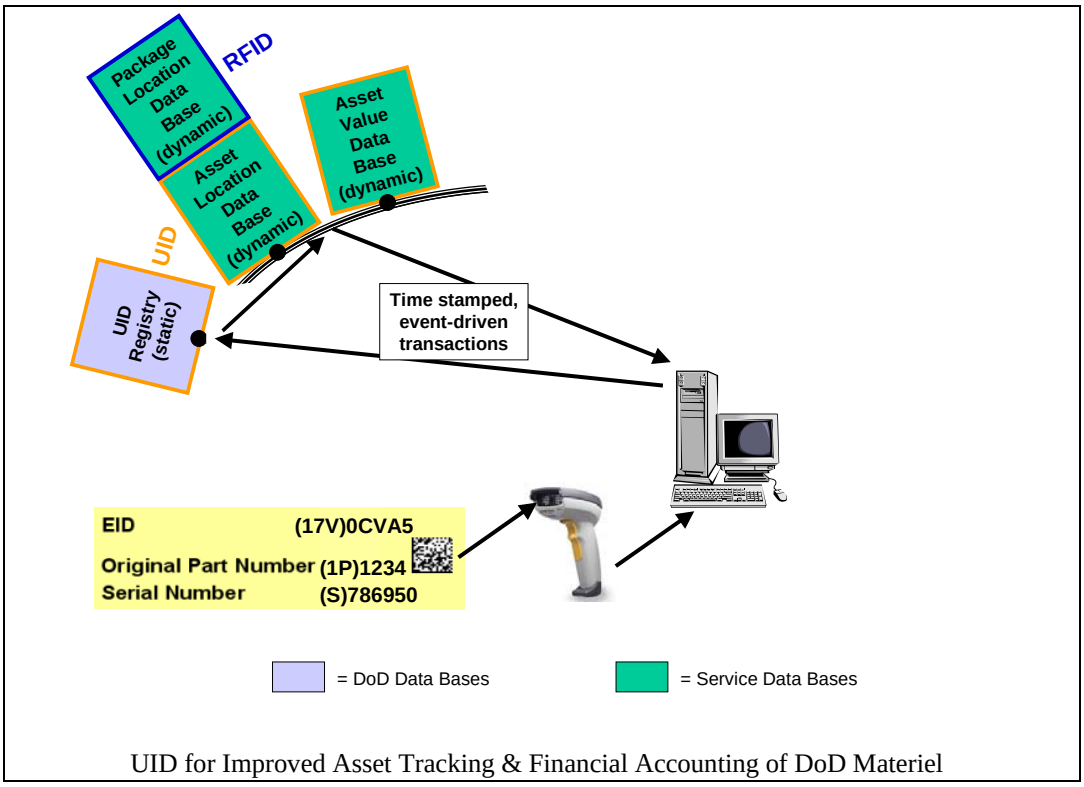

Figure 1-2.

Accomplishment of UID parts marking, UID Registry population and successful integration of UID technology with legacy financial and inventory accounting systems will produce the strategic outcomes currently envisioned for UID:

- Enhance logistics, contracting, and financial business transactions supporting U.S. and coalition troops.
- Enable DoD to consistently capture the value of items it buys, control these items during their use, reduce operating costs and combat counterfeiting of parts.
- Enable DoD to make appropriate entries into its property accountability, inventory, and financial management information systems toward achieving compliance with the Chief Financial Officers Act.

Beyond UID applications one and two, however, is the opportunity to profoundly improve not just the way DoD materiel is valued and inventoried, but also the processes by which repairable DoD materiel is sustained.

Improving Materiel Maintenance Capabilities for New Items

Riding the coattails of USD(AT&L)'s improved asset tracking/financial accounting mandate, additional application of UID will enable improved materiel mainte-

nance for new repairable items through the wholesale activation of DoD's Serialized Item Management (SIM) Program (see DODD 4151.18[13] and DODI 5000.2[14]). Commercial and organic suppliers of new repairable materiel will be required to expand upon the item's inventory and financial accounting pedigree by providing baseline configuration, reliability and maintenance information for posting to legacy Service SIM data bases (or to newly created data bases if none currently exists for the specific repairable item).

Improving Materiel Maintenance Capabilities for Legacy Items

UID application #4 brings all significant legacy repairables into SIM. Capitalizing on UII marks, static & dynamic UID data bases, UID readers/software and the Automated Information System (AIS) infrastructure already put in place to enable improved legacy asset tracking and financial accounting, DoD maintainers and in-service engineers need only compile relevant legacy item configuration, reliability and maintenance information for posting to the appropriate SIM data base(s) to enable automated Serialized Item Management for the DoD repairables which require this capability.

Thus, as UID implementation progresses from application #1 through application #4, the UII will ultimately be associated, not only with an item's static "birth record" data and its dynamic inventory and financial accounting information, but also with it's dynamic configuration, reliability and maintenance history. In the same way that an individual's unique Social Security Number is used by physicians to locate and access the correct medical record so that patient diagnosis and treatment may be accomplished effectively, efficiently and safely, the UII will point to repairable-specific information within the static UID Registry and the dynamic Service Maintenance Management Information Systems (MMISs). Using knowledge derived from this data, DoD maintainers will be able to troubleshoot faster, manage configuration better and more rapidly take actions to restore inherent equipment reliability when unacceptable mean-time-between-removals (MTBR) is discovered. Capitalizing on UID/SIM, maintainers will make better, more informed decisions, discharging their support responsibilities in less time with reduced effort and cost.

Figure 1-3. depicts a notional network of interconnected computers and data bases designed to improve the Services' ability to capture, store, retrieve and update information about the value and physical location of its inventory of personal property items, *as well as* information about item configuration, reliability, repair history and ownership cost. As noted above, the key enabler is UID. The networked AISs shown in red collectively comprise the virtual SIM data base. The SIM data base, combined with data capture tools, such as the UID reader, and with maintenance data transaction protocols form the basis of an Automated Maintenance Environment (AME).

[13] Maintenance of Military Materiel, March 31, 2004

[14] Operation of the Defense Acquisition System, May 12, 2003

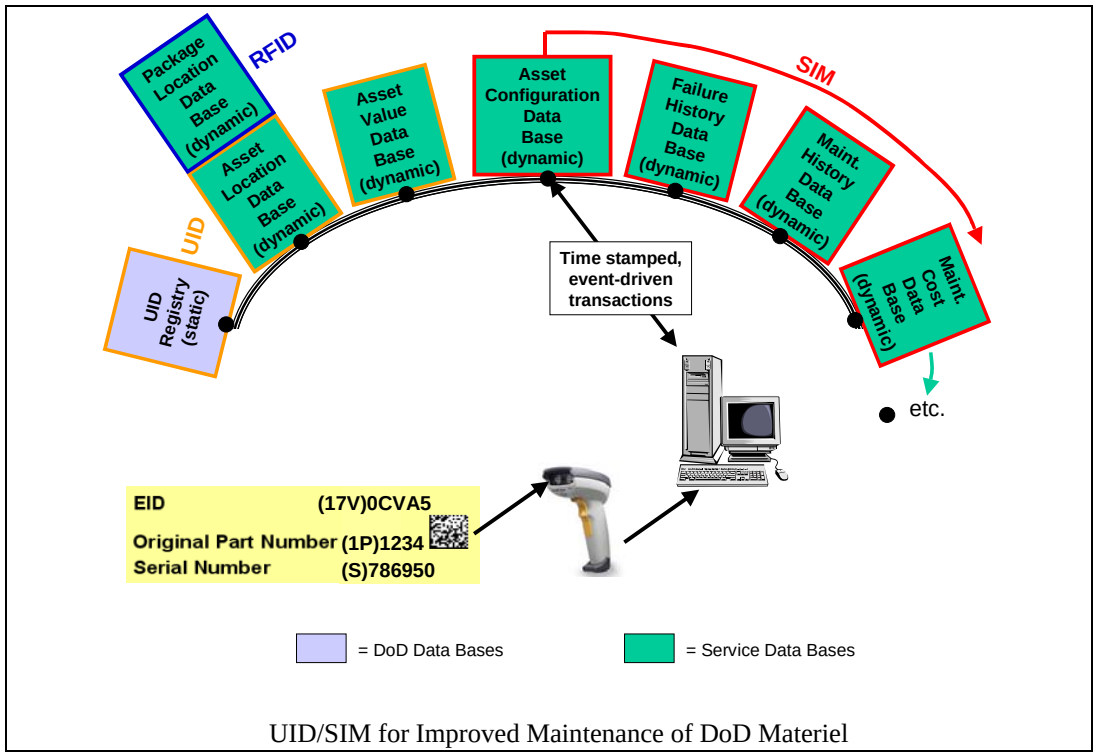

Figure 1-3.

Universal UID/SIM for DoD maintenance is unquestionably a work-in-progress. That many unanswered questions still exist merely confirms that many important decisions have yet to be made - decisions which the DoD depot maintenance community wants to, and can, influence. This Plan begins that process by suggesting UID business rules and doctrine for depot manufactured items and for legacy item marking in the depots.

Chapter 2 Preparing for UID Capability Establishment

As discussed in Chapter One, the OSD UID initiative has the long-term potential to transform not just the way decisions are made about global materiel asset tracking & financial accounting, but also the way decisions are made about global materiel maintenance. This Plan identifies the high-level depot roles and responsibilities critical to successful UID implementation and employment.

UID policy imposes very specific requirements upon commercial suppliers of tangible items who wish to sell materiel to the Department of Defense:

- They must determine which items need to be marked.
- They must develop a corporate strategy and plan for acquiring the capability to mark required items.
- They must determine where to mark specific items and what marking technology to use.
- They must mark the items.
- They must determine what item data needs to be associated with the UII mark and where the data may be obtained.
- They must obtain UID data for each individual item marked and compile the data in approved format.
- When shipping the item, they must scan the UII and transact all DD250 UID data to the Government customer for posting to the UID Registry.

Additionally, they must determine how to charge for UID marking and associated expenses[15]. Each of these requirements applies equally to the organic DoD depots, whether for marking manufactured items or legacy parts marking. Moreover, in cases where the depot manufactures an item for its own use (such as a piece of test equipment or a fabrication jig or fixture), the depot is also the Government's

[15] One immediate effect of OSD's new UID policy is a dramatic increase in the requirement to serialize parts. In examining the policy and following the guidance, the CH-47 Program Management Office has seen a 10 fold increase in the number of parts that will be uniquely tracked. If this number is valid across all weapon systems, DoD's vendors will have to implement process changes on their manufacturing and shop floors to accommodate an order of magnitude increase in serialization.

accepting activity for the new equipment, and must exercise those "customer" UID responsibilities, as well.

Figures 2-1. and 2-2. illustrate typical vendor and customer roles and responsibilities associated with UID implementation for newly manufactured items. Not detailed, but included within the first block ("contract award") are the roles and responsibilities of the Program Office. It is up to the Program Office to determine what items need to be marked, to communicate those decisions to the manufacturer or other marking activity, and to fund the commercial manufacturer or depot for some or all of its UID expenses.

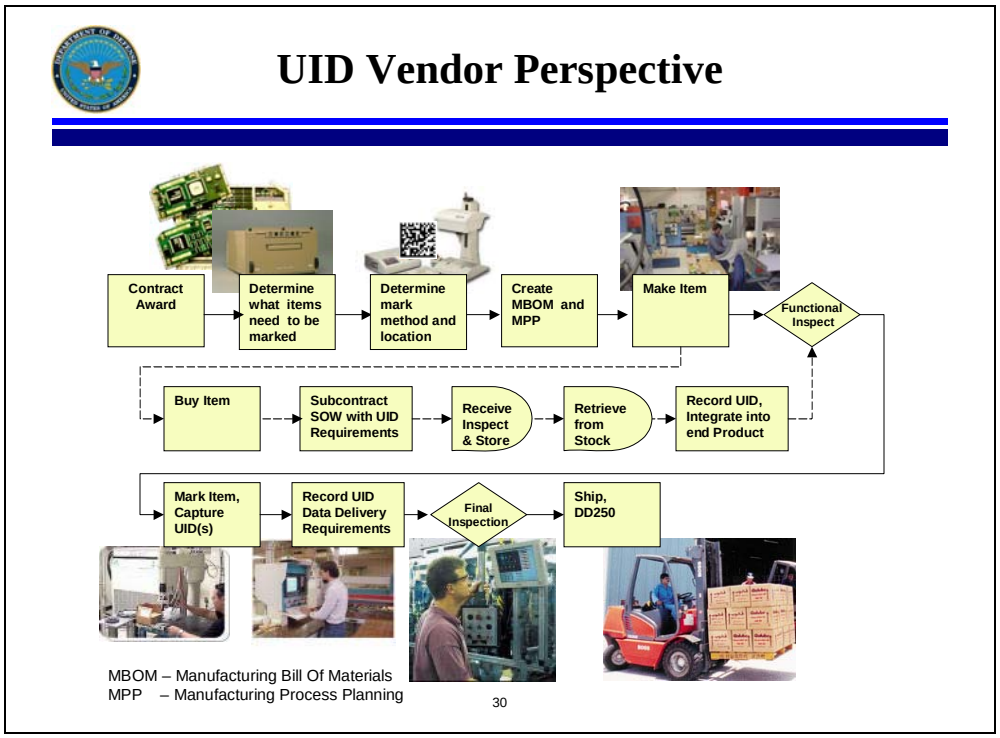

Figure 2-1.

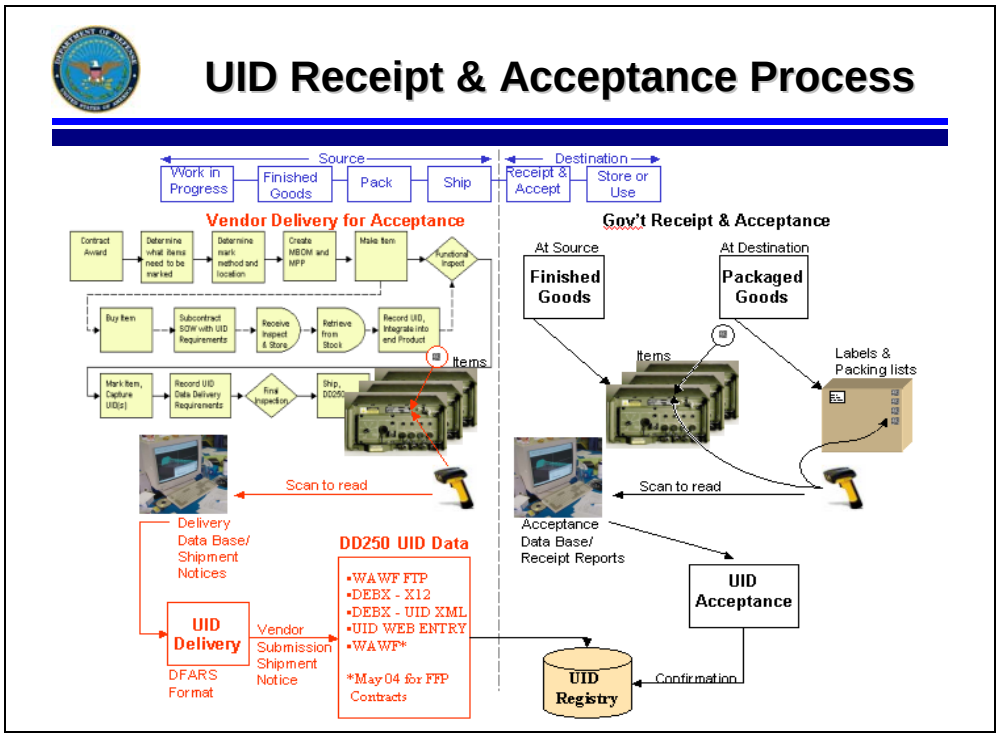

Figure 2-2.

UID roles and responsibilities for legacy parts marking will be similar to the roles and responsibilities associated with new item marking. However, whereas the primary marking policy target for *new* items is commercial industry, with only a secondary concern for public sector (depot) manufacturing, the primary target for *legacy* marking policy is the organic depot community, with only a secondary concern for the commercial supplier. In other words, the PMO will have to tailor commercial "new item" marking business rules to fit the organic depot manufacturing environment, and tailor the organic depot legacy parts marking policy to fit the commercial depot environment.

Since both the depots and commercial suppliers are being directed to comply with the same overarching UID policies, a logical approach to a depot UID Plan would simply mirror the "new item" requirements imposed on the private sector (contractual language, business rules, financial incentives, etc.) and expect the organic industrial facilities to respond just like their commercial counterparts (management strategies, production processes, performance metrics, etc.). Likewise, it might initially seem logical to mirror the "legacy item" requirements imposed on the public depots and expect the commercial depots to respond just like their DoD organic counterparts This "one-size-fits-all" approach has superficial appeal; it simplifies the overall management challenge by minimizing variability and promotes public/private equity by suggesting a balanced "playing field". Unfortunately, the "one-size-fits-all" approach is also unimplementable. DoD's depots are not businesses. They provide products and services, not within a free-market buyer-seller environment, but rather in a monopoly/monopsony environment as

directed by their military chain-of-command, without legal contracts or payments in excess of costs (profit). FAR & DFAR clauses, CLINs, DIDs and contract Statements of Work are not used in the public sector as they are in the private sector. Therefore, the Plan for implementing UID in the public depots (both new manufactured item marking and legacy parts marking) must differ from that (or those) employed in the private sector. The depots must be tasked differently, funded differently and will likely employ tailored processes to create and deliver marked products. The markings themselves, however, and all associated UID data will be fully equivalent regardless of the marking activity.

OSD POLICY FLOW-DOWN TO THE DOD DEPOTS

DoD's organic depots are large military organizations which execute assigned missions within a well-defined chain-of-command. Their activities are governed by policies established by OSD and the Services[16]. These policies define both depot responsibilities and the amount of authority delegated to the depot Commander. Many depot policies are general in nature, affording depot Commanders latitude to select the most effective and economical way to discharge assigned responsibilities. Other policies are more specific, limiting options or even requiring that specific procedures or processes be implemented. Policies flow down the chain-of-command; policies issued by OSD are usually interpreted by the Services, repackaged, and reissued as guidance to the individual depots. (In some cases, Service policies are interpreted one or more times by echelon one, two or three commands before being published as Directives or Instructions for the depots.) Many policies in effect at the depots do not originate within OSD, but reflect Service or subordinate command requirements. OSD policies, because they are universally applicable within the defense depot enterprise, tend to foster commonality and standardization. Service and Command policies not adopted across the enterprise tend to foster diversity. Diversity is often desirable, as when local operating environments demand tailored business rules or production processes. Standardization is advantageous when close cooperation among depots is needed in order to execute a collective mission or when "economy-of-scale" opportunities are available to reduce costs.

While there are a number of formal OSD and Service policy documents effecting depot operations, there is little or no guidance on UID parts marking and data management. This is not surprising, of course, because the policies are both new and evolving. It might be argued that formal guidance to depot commanders and/or their chain-of-command is not needed, that Service Acquisition Executives (SAEs) are responsible for figuring out how to implement UID policy, and they'll get their depots on board. On the other hand, given that *some kind* of direction is going to have to be given to each of the depots by *someone,* it might be advantageous to seek standardization (or, at least, commonality) since the prime utility of UID -- serialized item management -- is most certainly going to cross weapon systems and Services. UID needs to be "open architecture" so that any future de-

[16] And, in some cases, by Public Law.

cision maker can “plug-and-play” his decision support system software without concern for incompatible business rules, protocols or data formats. This standardization is probably best accomplished by centralizing depot UID policy formulation. It is, therefore, recommended that OSD (the Assistant Deputy Under Secretary of Defense for Materiel Readiness & Maintenance Policy) prepare and publish a (high level) depot UID implementation and employment policy document.

DEPOT UID PLANNING AND RESOURCING

Planning Challenge

Once the Depot Commanders’ responsibilities and authority for complying with OSD UID policy have been determined and published, it is important that plans be prepared describing how the depots intend to discharge those responsibilities. USD(AT&L)’s 29 July 2003 UID policy memo on new equipment marking (Appendix A) directed that “...all program managers for new equipment, major modifications, and reprocurements of equipment and spares shall begin planning to apply Unique Identification (UID) on tangible items...” In his 3 September 2004 UID policy update (Appendix B), USD(AT&L) requested that “... the Component Acquisition Executives direct all program and item managers to begin planning for the application of the UID to the Department’s existing legacy items in inventory or in operational use.” Finally, in his 23 December, 2004 Memo (Appendix C), USD(AT&L) requested “...that the Military Departments direct all program and item managers to plan for and implement UID for existing legacy personal property items in inventory and in operational use...” “ACAT 1D programs must submit UID program Plans to the UID Program Office by June 2005. All other programs must submit plans to their respective Milestone Decision Authorities by January 2006. The plans should target Fiscal Year (FY) 2007 as the point by which: (a) all existing serialized assets that meet the criteria for UID have been entered in the UID registry, and (b) UID marking capabilities have been established for all existing items and embedded assets such that marking can commence as applicable equipment are returned for maintenance.” Program and item managers were further requested to “...plan to complete UID marking of all items and all applicable embedded assets within existing items by December 31, 2010.”

This is an extremely aggressive planning challenge. It is inconceivable that quality Program Office plans could be prepared in the time allowed without aggressive depot participation.

The depot “chapter” of each Program Officer’s UID plan, which will necessarily be specific to the depots which repair the PM’s equipment, needs to be sufficiently detailed to serve as the basis for UID manpower, equipment and facilities requirements determination, as well as overall depot UID program budget preparation and defense. The plans must cover, at a minimum, the actions (and associated schedules) needed to establish, or otherwise gain access to the capability to

mark items. They must also explain the processes which will be used to associate minimum required UID data (item's "birth record") to the UID mark (item's "SSN"), and the process by which UID data will be managed over time.

At the depot, itself, there must be a complementary UID implementation planning document which "rolls up" the individual PMO plans into an integrated facility UID Plan. The need to integrate the strategies, priorities and milestones of scores of different PMOs into a coherent (and executable!) depot plan underscores the advisability of standardized OSD depot UID implementation policy guidance to set boundaries and prevent conflict.

Planning for Full Operating Capability (FOC)

While it is critically important that the DoD depots achieve the capabilities needed to implement UID parts marking and data management for asset tracking and financial accounting, the vision end state for UID/SIM at the depots is to create a business architecture which contributes to a seamless data flow within a net centric automated maintenance environment. This vision will be realized by achieving DoD UID and SIM policy goals within the maintenance enterprise.

UNIQUE IDENTIFICATION AND SERIALIZED ITEM MANAGEMENT

For years, the maintenance community has wanted a paperless means of capturing and recording information about the life history of repairable parts and equipment. While this capability has been selectively developed at some activities and in some warfare communities, technological advances have only recently emerged that will enable maintainers to identify and track equipment on a wholesale basis. Identification technologies have expanded beyond the Universal Product Code (UPC "barcode"). Automated systems are in place or being planned to link localized centers into an integrated network of information flow. For the maintenance community, these new technologies and systems mean that the "pedigree" -- not just changes in physical location and asset value, but also failure histories [reliability], maintenance histories [repair actions taken, materiel used, man-hours used, cost, etc.] and configuration histories [including past and current "usable-on" codes] of individual repairable parts -- can be centrally stored and accessed anywhere in the world to make repair troubleshooting, configuration management and reliability improvement efforts easier and less expensive.

The most common application of the technology during the past two decades has been to track items by Serial Number. Serial number tracking (SNT) is the identification and use of pertinent historical configuration and asset location data for critical repairable items. SNT efforts, the basis of DoD's Total Asset Visibility (TAV) initiative, have existed most notably for such items as high-value parts, classified assets, aviation "safety-of-flight" parts and many missile system components. For items in the system, SNT provides an ability to monitor installation and removal data as well as changes to item configuration. It enables asset inventory validity/traceability, spares procurement decisions, and transportation visibil-

ity. For most of its history, SNT was an entirely manual system based on paper records and logbook entries. Only recently has automation been selectively introduced.

Serialized Item Management takes Serial Number Tracking to the next performance level. The objective of SIM is to improve the effectiveness and efficiency of all DoD materiel sustainment decision making. SIM, or "pedigree management", as it is sometimes called, accomplishes this objective by providing comprehensive, near real time item information to maintenance, transportation, supply and financial managers, as well as to the in-service engineers supporting the sustainment community.

SIM implementation objectives are well documented. In September 2002, the Deputy Under Secretary of Defense for Logistics and Materiel Readiness (DUSD(L&MR)) established policy for SIM to strengthen DoD equipment maintenance operations.[17] The SIM program was designed to:

- Identify populations of select items
- Mark all items in the population with a universally unique identification number
- Enable the generation, collection, and analysis of maintenance data about each specific item.

In addition to the September 2002 policy memo, the requirement to implement SIM is contained in DoD Instruction 5000.2[18] and DoD Directive 4151.18[19].

SIM seeks to utilize automatic identification technology and serial number tracking technologies and programs as integral elements to provide comprehensive and accurate information to maintainers and other sustainment decision makers. Rapid access to historical life-cycle information, elimination of time-consuming and error-prone manual paperwork and dramatically improved tracking of asset performance for reliability, maintainability and cost analyses are some of the benefits of SIM.

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[17] Memorandum for Secretaries of the Military Departments, *Serialized Item Management*, Deputy Under Secretary of Defense for Logistics and Materiel Readiness, September 4, 2002.

[18] Paragraph 3.9.2.4.1 - "PMs shall optimize operational readiness through affordable, integrated, embedded diagnostics and prognostics, and embedded training and testing; serialized item management; automatic identification technology (AIT); and iterative technology refreshment".

[19] Paragraph 3.2.5 - "[Service maintenance programs shall]...employ Serialized Item Management (SIM) techniques to effectively manage populations of select items throughout their life cycle. SIM programs shall focus on providing comprehensive and timely data for each identified item. DoD materiel shall be equipped with Automatic Identification Technology (AIT) allowing for paperless identification, minimizing data entry requirements, and facilitating digital storage and retrieval of essential information including maintenance history. SIM programs shall build on existing serial number tracking initiatives and leverage continuing progress in AIT."

AUTOMATED MAINTENANCE ENVIRONMENT

The single biggest challenge which UID must overcome is not parts marking; it is building the Automated Information System which will enable decision makers to update and monitor the pedigree of millions of new and legacy repairable items on a near-real time basis. Without a capability to transact and retrieve information about marked items, there is no utility to UID, and certainly no meaningful return-on-investment (ROI).

The AME is an overarching concept which integrates procurement, sustainment and operational processes into an enterprise management tool. Rather than continue with numerous stove-pipe systems, the AME combines the multiple processes through automated technology and digital systems to create a total information environment.

Achieving Full Depot Operational Capability (FOC) in UID/SIM must look well beyond the ability to mark parts, and even beyond the ability to support OSD's personal property inventory and financial accounting imperative, and consider the ability of the depot to be part of the Net Centric Automated Maintenance Environment envisioned by DoD. To achieve that status, the depot must have its maintenance, repair & overhaul (MRO) and manufacturing processes, including parts marking, fully integrated into a robust data network that permits visibility across the depot environment. It must, further, be in a position to capitalize on the ability to view the life history "pedigree" information associated with individual marked repairable items. This capability enables not just more effective and efficient troubleshooting and repair, but also detailed parts usage and reliability tracking, accurate repair cycle-time evaluation and management, and near real-time sustainment cost accounting.

PLANNING ACTIVITIES

Figure 2-3. depicts the top-level UID implementation activities which must be planned for. This planning cannot be accomplished by either the depot or the Program Office working alone -- it must be the product of an integrated project team (IPT) comprised of empowered representatives of all of the functional organizations which have a stake in the successful outcome of UID.

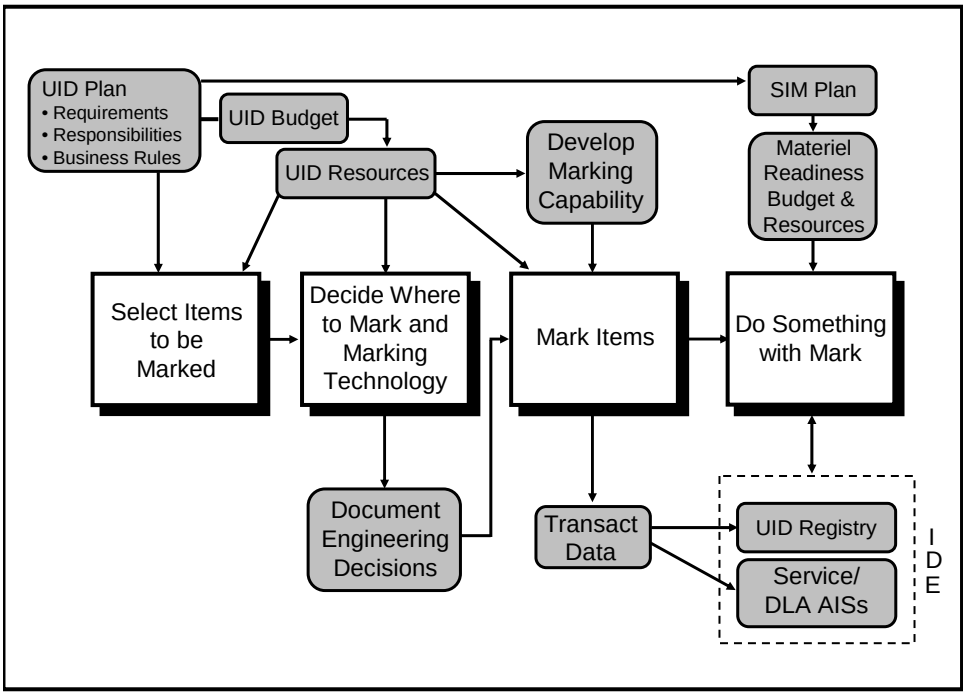

Figure 2-3

In support of FOC, the PMO/Depot UID IPT needs to oversee and document plans and procedures in the following eight areas:

1. **As-Is Process Mapping**. The first step that must be accomplished within the depot environment is to do an "as-is" process model from the view point of SIM. There are processes in existence today within the depots that associate serial numbers with item data, and record that data in a repository (e.g., legacy serial number tracking (SNT) programs). Many of these processes are paper based; they must be clearly mapped and documented in order to set the stage for UID/SIM process reengineering (as required).
    a. Depot MRO and manufacturing processes must also be mapped at a high level to determine how and where one can insert parts marking capabilities.
    b. For the FOC determination, the "as-is" MRO and manufacturing process models will baseline the extent of AIT integration and employment within the depot environment.
2. **Linking to UID Registry and Dynamic Data Bases.** For both new and legacy parts, there is a requirement to register the UID data elements in the DoD Registry. This process is defined for new products within the Wide Area Work Flow (WAWF) and for legacy parts within an XML schema (described in detail in Chapter 3). Both of these processes must be documented at the local level to permit the data to be registered without manual transcription. Likewise, the process for associating the UII with item data stored in dynamic SIM data bases, the process for downloading and updat-

ing the data, and the process for returning the updated data to the designated repository must be documented at the local level (see process 4 below).

3. **Establishing Uniqueness of Data Elements**. Each depot must have in place a process for establishing a UID serialization capability for both new and legacy parts.
    a. For new parts, the following is recommended :
        i. EID – Depot CAGE Code
        ii. Serial number – Unique within CAGE Code
        iii. Part Number – Current part number
        iv. DoD Construct 1- This construct conforms to the UID policy with the smallest number of data elements and is compatible with current SNT policies within the three services.
    b. For legacy parts the data elements for establishing the UII can be the same as for new parts but there must be a link to the legacy information as it appeared on the part when it entered the depot. This requires the file that is transferred to the DoD registry to have both the UII information and the legacy data which might include serial number, CAGE code and part number.
4. **Establishing a Local Database.** This key element of UID/SIM capability establishment will centrally control the UID serialization process. This database will act as the touch point of the AIT information architecture for the depot. As the depot information system matures, this central facility will be the foundation for all of its in-service support processes (including, but not necessarily limited to manufacturing, MRO, and sustaining engineering). Additionally this database would be the single vehicle to share item "pedigree" data both internally and externally. Customers for this data include the DoD UID registry, the Program Management Offices (PMOs), the original equipment manufacturers (OEMs) and the operational equipment sustainment managers.
5. **Establishing the Capability to Physically Mark the Parts:** Depots will have to decide on whether to establish the capabilities locally or to contract for the services needed.
6. **Drawing Change Processes.** It is necessary to establish formal links to the cognizant technical engineers responsible for item configuration control. These individuals may reside within the PMO, OEMs or vendors, or the DoD depots or other DoD field activities. Only the cognizant technical engineer may approve how and where marking will occur. This is critical because the depot will not only mark legacy parts but will also receive parts that have been marked at other locations. It is important that all these different sources are coordinated. Most of this coordination can be accomplished through the business processes associated with drawing changes. It is critical that the item repair/rework specification and depot maintenance work requirement (DMWR) instructions align with the vendor and OEM drawings.

7. **Engineering Analysis for Marking Approval.** It is necessary that an effort that closely parallels the current formal configuration change process is established to maintain control of legacy UID parts marking. As marking technology progresses, we must have the process in place that will provide the necessary engineering analysis to approve the appropriate marking techniques on various components.
8. **Modifying Shop Routers.** In line with the drawing and engineering approval cycle, the depots must have a process that permits easy modification of local shop routers to address the need to integrate industrial processes with AIT on the shop floor. In the first instance this will mean new repair/rework SPECS to mark parts as part of the MRO or manufacturing process. In the second case it will potentially mean changing the work flow to capitalize on the fact that there will be marked parts on the shop floor. Coupled with reading hardware and changes in the information systems, there exists the potential to gain significant benefits in overall depot efficiencies.

These eight areas are discussed in greater detail later in this planning document.

Planning for Initial Operating Capability (IOC)

As a sub-set of FOC, IOC represents the point at which the depot is capable of performing minimum essential UID tasks[20]. UID IOC includes process and information infrastructure capabilities associated with UID data management, as well as the ability to acquire and operate parts marking hardware.

The recommended minimum achievements needed for an organic depot to declare UID Initial Operating Capability fall into three categories: (1.) the capability to responsibly plan and manage UID implementation at the depot, (2.) the capability to implement approved UID AIS plans and policies at the depot, and (3.) the capability to implement approved UID parts marking plans and policies at the depot.

1. Planning & Management.
    a. Depot/Program Office Integrated Project Teams (IPTs) to define roles and responsibilities and to plan and execute capability establishment chartered and functioning.
2. Implementing Processes (UID AIS).
    a. Local serialization schema determined.
    b. Central data base which will become single touch point for UID stood up.

[20] Note - UID "capability" only has meaning as it is applied to a specific and finite population of tangible items. A depot may have full capability for some NIINs, and have only partial capability, or no capability for other NIINs. The priority order for IOC/FOC establishment at a given depot will be determined by the cognizant PMO.

   c. Communication with DoD Registry for both new and legacy parts established. This communication must be automatic and not involve human intervention to transact data.
3. Implementing Processes (UID parts marking).
   a. Capability to apply UIIs to requisite parts, as determined by the Depot/Program Office IPT, established.
   b. Parts marking effort initiated on select items as called out in updated repair/rework specifications and depot maintenance work requirement (DMWR) instructions.

A detailed discussion of IOC criteria is found in Appendix G: *Approach to UID IOC at DoD Maintenance Depots,* OADUSD(MR&MP).

Resourcing Challenge

Since the preponderance of legacy UID activity between now and 2011 will take place in the DoD depots, by extension, the majority of resources for non-recurring capability establishment and recurring parts marking and UID data management will be required by the depots. Resource planning is one of the UID wolves closest to the PMO/depot door.

Because of OSD Planning, Programming, Budgeting and Execution System (PPBES) timelines, depot UID resource plans need to be prepared and approved quickly if depot IOC and FOC milestones are to be achieved. On May 11, 2005, USD(AT&L) issued UID budget instructions to the Component[21] acquisition programs to "...specifically identify their UID support in applicable budget submissions in their existing budget lines in the FY07-FY12 budget" (Appendix D). For budget preparation purposes, "UID implementation" is considered to apply to both new acquisition items and legacy items in inventory and operational use. Acquisition program UID budget submissions are to address modernizing infrastructure, reengineering business processes and revising Automated Information Systems to implement UID, with particular focus on the marking and data capture aspects of UID implementation.

From the depot's perspective, two related, but different resourcing plans are required, one strategic and one tactical. The two must be developed in parallel, because they inform each other. The tactical depot UID plan, which is specific to each individual depot, addresses the questions:

1. What parts am I going to mark? (workload forecast)

2. What do I need to do to develop the capability and capacity to execute the workload, and how much will it cost (non-recurring investment)?

[21] The Services and Defense Agencies

3. What do I need to do to actually execute the workload, and how much will it cost (recurring expense)?

The tactical plan describes how much UID money is required at each depot, and what it will be spent on. It forms the basis for the annual depot UID budget submit.

The strategic depot UID plan describes where the money is going to come from. The strategic UID resourcing plan will likely not be depot-specific, but will reflect how each Service intends to fund UID marking and associated expenses in all of its depots. Funding requirements will include (but not necessarily be limited to):

1. Non-recurring UID planning
2. Non-recurring UID capability establishment
3. Recurring engineering analyses (to determine where and how to mark items)
4. Recurring UID data acquisition (to build “birth records”)
5. Recurring UID labor & material (to mark items)
6. Recurring UID data maintenance/data management (to transact and capitalize on UID data)
7. Recurring commercial contracts (if any)

The strategic depot UID funding plan is above the level of the various Program Office/depot IPTs, although IPT input will surely be useful. The strategies must be prepared and published by senior Service Acquisition Executives and Comptrollers. Until this happens, until the source of funding for parts marking in the depots is identified, UID (especially legacy UID) is on “hold”. In general, there are three options for funding Depot UID:

Alternative one considers UID parts marking a Program requirement to be funded by the cognizant weapon system Program Manager or other acquisition agent (e.g., Commodity Manager, Item Manager). This will require that UID budget lines be established within each Program Office. The depots would be given program dollars to develop the capability to mark items and manage UID data, and would respond to funded task orders in the year of execution to accomplish parts marking and data management.

Alternative two considers UID parts marking an Operational requirement (because the return on OSD’s UID investment ultimately benefits the warfighter by increasing materiel readiness and/or reducing sustainment cost) to be funded by Service O&M accounts. This will require that UID budget lines be established

within each Major Claimant (Operational). Non-recurring and recurring resources would be provided to the depot as in alternative one, except the dollars come directly out of the warfighter O&M account.

Alternative three considers UID parts marking a normal part of the depot manufacturing/repair process, and funds it in exactly the same manner that manufacturing/repair is funded today. This typically requires that the cognizant PMO (or Commodity Manager, or Item Manager) fund non-recurring capability establishment. Recurring resources are provided by increasing the work scope of the depot-level repair by the amount (labor & materiel) required to mark the part and collect/record/transmit UID data to the registry. The scope increase is institutionalized by updating the item rework specification and/or the depot maintenance work requirement (DMWR) instructions. This has the effect of increasing the price of each manufactured item marked, requiring that customer O&M accounts (which are used to reimburse the depots for the cost of manufactured items) be increased proportionally.

Recommended Depot UID Resourcing Strategy

Alternative three is recommended. Since it does not change the status quo, no non-standard business rules need be devised and implemented. There is no requirement for added overhead personnel in either the program office or on the operational Claimant's staff to manage an annual depot UID budget. While the price of depot-level repairs will increase -- something traditionally to be avoided -- the corresponding increase in value to the warfighter, especially when a critical mass of parts has been marked and wholesale serialized item management is enabled, will be even greater.

Chapter 3 Establishing Depot UID Capability

UID implementation – including both depot manufactured items and legacy items - can rightly be considered a transformational capability for the Department of Defense. Such effort poses risk – but it also offers great reward. Once the enabling policies, which specifically include decision authority (policy flow-down), execution roles & responsibilities and UID resourcing, have been documented, wholesale depot UID implementation can begin.

The implementation effort must strike a balance between the short term requirements and the long term goals. In the near term, 99% of the effort should be focused on what needs to be accomplished for the depot to simply deliver a UID-marked part (with accompanying "birth record" data) to the DoD Supply System. But the mid-range goal of pedigree data sharing within the depot and up and down the supply chain must also be considered. Beyond that is the ultimate goal of Serialized Item Management and the Product Life Cycle Support (PLCS) capability that will provide increased weapon system readiness or reduced materiel sustainment cost, or both.

The diagram in figure 3-1 shows the three main areas of UID concentration for DoD's depots in support of IOC: Engineering, AIS/Database, and Production. Process changes are required in each area. As well, there is significant collaborative effort needed among the three areas. Successful UID implementation is only possible if the entire enterprise is aligned and motivated to collectively meet expectations.

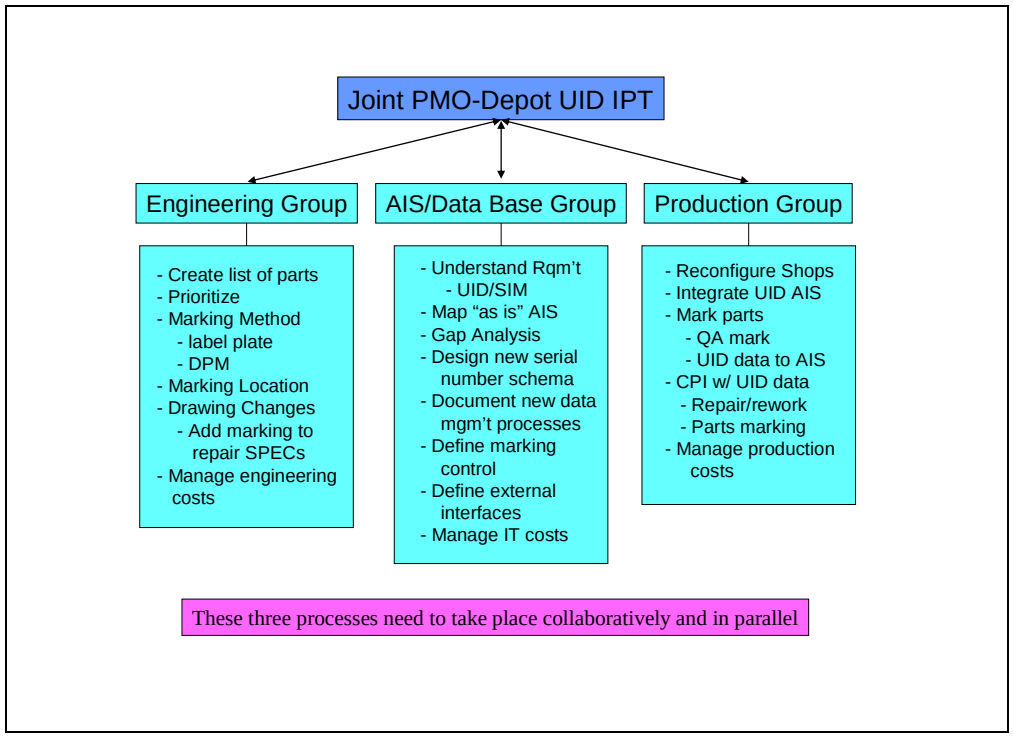

Figure 3-1

The planning associated with each of these three areas will be discussed in more detail in the following sections.

THE JOINT PMO/DEPOT INTEGRATED PROJECT TEAM (IPT)

Legacy UID cannot be implemented by any Weapon System Program Office working alone, nor by any DoD Depot, working alone. A joint PMO/Depot Implementation Team is essential. Similarly, no single group within the Depot has all of the capabilities needed to successfully implement UID at the facility -- cross-functional participation within the Command is mandatory. Accordingly, it is paramount that a cross-functional team, one that has clear senior management support, be chartered at the earliest opportunity.

This PMO/Depot UID IPT[22], meeting regularly, is accountable for forward progress. Formal presentations lead by senior management at the beginning of this process set the tone, communicate the vision end state and present the milestones. Thereafter the cognizant managers and subject matter experts collaborate to re-

[22] Since each DoD depot supports multiple weapon systems, and therefore multiple PMOs, there will very likely be multiple PMO/Depot UID IPTs working simultaneously. Depot resources will have to be multiplexed among IPTs to cover the requirement. Similarly, most weapon systems are supported by more than one depot; PMO resources will also have to be multiplexed across depots to ensure coverage.

move barriers to progress. Insurmountable barriers are elevated up the chain-of-command. As issues are raised, solutions found, and decisions made, the IPT Leader documents and communicates progress made in support of assigned milestones.

UID implementation within the depot will affect a great number of systems and processes. An area of early and particular concern is the UID-enabling AIS. The AIS/Database Working IPT (WIPT) needs to develop an automated Serial Numbering scheme, databases, and control processes that work for both new and legacy parts. This is particularly true if the same computer application/database systems are used to track both the manufacture and the re-manufacturer/repair processes at the depot.

Identifying What to Mark

One of the early tasks of the PMO/Depot IPT is to create a prioritized list of all the parts that need to be marked at the depot according to the UID Policy. The initial focus will likely be on the depots manufactured items to limit the complexity. Once the selection process been defined and exercised, the IPT can go back and utilize the same process for the much greater volume of legacy parts that need to be marked and tracked. Assuming the success of both strategic and tactical depot UID resourcing plans, investment dollars will be budgeted so that marking capability establishment can begin.[23] After gaining the capability, but before a DoD depot can undertake to mark a specific part or piece of equipment, it must be officially tasked with a requirement. This official tasking is important not just to preserve the discipline with which Depot Commanders employ their resources, but also to ensure that the depot will be financially reimbursed for its efforts. The tasking document, which is functionally equivalent to a commercial contract, will typically take the form of a UID policy compliance requirement added to the repair/rework specification and/or the depot maintenance work requirement (DMWR).

Considerable guidance exists from OSD regarding item selection. A “decision algorithm” (Figure 3-2) has been prepared by the UID Program Office, and is often referenced.

[23] The term “marking capability” must, in every case be construed as including the capability to obtain, store and transact the UID birth record data and other required pedigree data. Without the complementary AIS, the UID mark has zero utility.

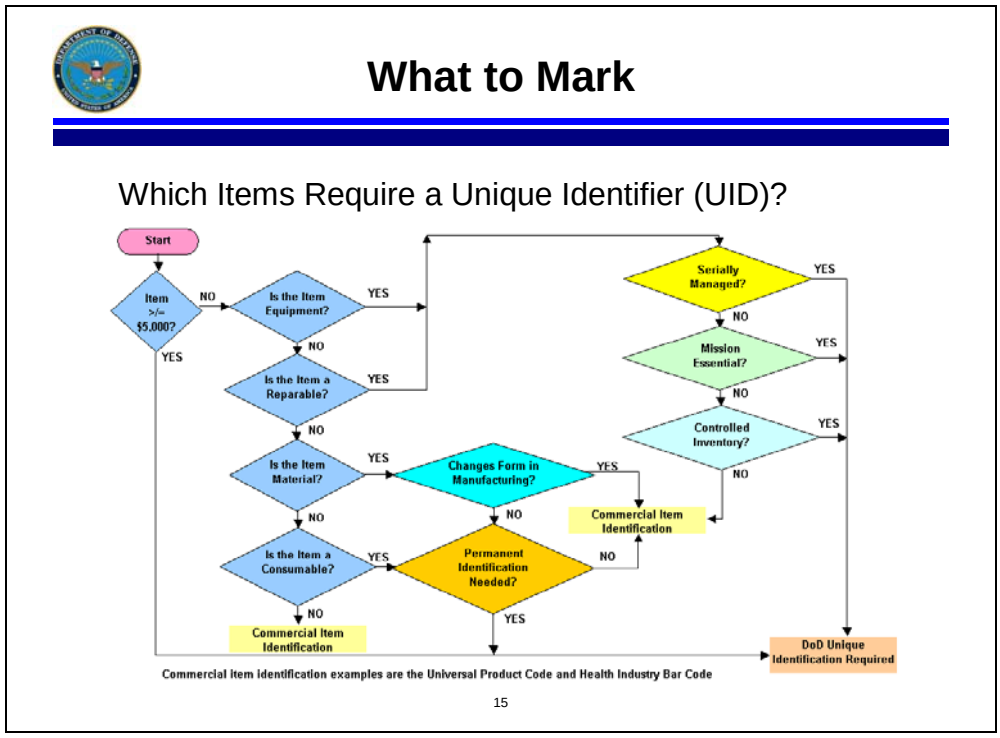

Figure 3-2

Great detail is contained in the *Department of Defense Guide to Uniquely Identifying Items - Assuring Valuation, Accountability and Control of Government Property* issued on 16 April, 2004 by the Office of the Principal Deputy Under Secretary of Defense (Acquisition, Technology and Logistics). Guidance contained in this document and in the various UID policy Memos issued by USD(AT&L) clearly gives the Program Office responsibility for specifying the items to be marked.

As was the case with the UID resourcing issue, "deciding what parts to mark" has two dimensions, one strategic and one tactical. At the strategic level, a decision needs to be made concerning which *populations* of identical tangible items will be marked. If, for example, a strategic decision is made to apply a UII to the digital fuel control on the AGT1500 gas turbine engine which powers the M1A1 Abrams Main Battle Tank, that means that all of the AGT1500 fuel controls owned by the Department of Defense will be marked. Once the strategy is accepted, tactical decisions will be made regarding which of all the fuel controls in inventory should be marked today, and which tomorrow and which next week. The tactical challenge is essentially a workloading issue.

After the IPT has published its Master List, the requirement for physical parts marking is assigned to the depot. In many cases, legacy items have more than one designated overhaul point (DOP); it is incumbent upon the primary DOP to coordinate with all of the other depot organizations which perform depot repair (or modification) actions on the listed items (to include commercial depot repair ac-

tivities). Moreover, it is entirely possible that many depot-level repairables are repaired by Intermediate Maintenance Activities in the Field. The prime DOP must consider whether to include these organizations in the PMO/Depot legacy UID parts marking plan, and if so, how. The primary vehicle for integrating requirements and controlling the process is the item repair/rework Specification (and/or the DMWR). The DOP's tactical parts marking plan will be submitted to the PMO/Depot IPT for approval. The PMO retains oversight authority to ensure that UID marking progresses according to plan.

Create a Master UID Parts List

It is recommended that an easy, flexible, and shareable format, such as Microsoft Excel, be used to construct master lists. An Excel list is understood and accessible by most people, and it is easily shareable in the collaborative environment that is needed. If items get placed on this list, but later analysis removes them from UID consideration, that reasoning needs to be logged and retained to show that parts have not been inadvertantly missed. The use of Excel's features of filtering, sorting, color, and flexible data entry columns will make this list a very useable tool for many people to use.

The following represents a suggested list of column headings for the Master parts list that have been shown to be useful in other UID efforts covering both new and legacy part considerations. Each particular depot can modify this to meet its needs:

1. Name of Manufacturer
2. CAGE Code of Manufacturer
3. Manufacturer's Part Number
4. Part Name
5. Internal Part Number
6. NSN
7. (whether it is) Serially Managed
8. (whether it is) Mission Critical
9. (whether it is) Safety Critical
10. Functional Grouping (dynamics, landing gear, electronics, engine, etc.)
11. Buy or Make Part
12. Lead time on Buy
13. Lead time on Make
14. Relevant DMWR or other reference material
15. Next Higher Assembly
16. Marking Method (Label, dataplate, dot peen, laser etch, chem.etch, ink-jet, etc)
17. UID Construct 1 or Construct 2 serialization schema
18. Reason for exclusion from UID consideration
19. Responsibility and/or status of UID analysis
20. etc.

Use of the AutoFilter feature in Excel can make a very long list of parts user-friendly to enable different users to find exactly what they are looking for. Given the common template, multiple Engineering Groups can populate their lists in parallel and then all lists merged into the Master Parts List at a later time.

THE UID ENGINEERING WIPT

Supporting the Joint PMO/Depot UID IPT, the Engineering WIPT will assist the PM and Depot Commander select the parts which need to be marked. But, by far the most important responsibility of this group is to approve marking locations and technologies for every part which will receive a UII. This group must also maintain control of the configuration of every part marked by ensuring marking decisions are documented on applicable drawings, repair/rework Specifications and DMWRs.

Determining Where and How to Mark Items

Appropriate Marking Methods

This activity will be the most difficult task the Engineering WIPT will have to undertake, related to the fact that the UID data needs to be marked on the part by a computer-controlled process. Hand-written Vibro-peen or felt-tipped pen characters are no longer acceptable. In their place will be a computer-controlled process to mark a 2D Data Matrix bar code symbol, plus the human-readable characters applied via the same computer-controlled process to avoid creating typographical errors. Companies who have been doing this for 5 years have saved hundreds of thousands of dollars each year by removing the human error factor in marking very expensive parts. There is also the need to insure that the UII is applied to the part in such a way that it will be permanently readable. For many parts, e.g., those with data plates, that is probably not an issue. But there is a large population of parts where the only UID solution is to use Direct Part Marking (DPM).

The two methods (labels & data plates, and direct parts marking) are discussed briefly below.

Gummed Labels

These are by far the least expensive solution but they only work for parts that live in gentle and benign environments – office environments are an example. Paper labels are never acceptable. A polyester-type label is the minimum acceptable, and even then the label stock, ink, and adhesive have to be engineered to last the entire life of the part in the kinds of operational, shipping, and repair environments the parts will find themselves.

Data Plates

For parts that currently have data plates that remain readable for the life of the part, the simple solutions is use a similar data plate design, but the entire data plate has to be marked under computer control with the addition of the 2D bar code symbol. Hand-writing and hand-stamping of important data like Part Number and Serial Number is no longer acceptable. A redesign, possibly re-sizing, of the data plate can usually be accommodated fairly easily to allow for the UID requirements. An additional population that needs to be considered is all the parts which meet the UID-marking criteria, but which were never marked before. If there is room for a label/label plate, some minor reengineering may be needed (probably cheaper than going to DPM).

Direct Part Marking (DPM)

This represents the only permanent part marking technology for all the parts where neither gummed labels nor data plates are feasible. DPM solutions require engineering analysis to insure that the life and functionality of the part is not being compromised. Dot Peen, Laser etch, chem.etch, laser bonding and ink jet are all common methods of DPM. If parts are already being vibro-peened with a handheld marking tool, they can often be moved over to a computer-controlled dot peen machine with minimal engineering analysis. The engineering challenge will be for all the many parts which are currently not being permanently marked. Each must be individually analyzed against the array of DPM technologies available to determine the most permanent, cost-effective approach. Creating templates for similar kinds of parts and collaborating with other engineering activities which are working similar problems can improve analysis efficiency.

ENGINEERING ANALYSIS

Selection of the best direct marking technology for a particular application requires an intimate knowledge of the physical characteristics of the part, and an understanding of the part's operating environment, including the relationship of the part to other parts in an assembly (if any). In application, UID marks must not induce stress in stress-critical parts; they must not compromise corrosion barriers or otherwise serve as precipitating sites for corrosion initiation; they must not interfere with proper assembly of mated parts; and they must be protected from exposure to abrasion or other degradation as normal wear takes place. Additionally, the UID marks must be easy to read with commercially available 2D matrix readers. If possible, the marks should also be applied on the manufactured item so that the data can be read from the part while in the installed position.

The engineering analysis also requires an appreciation of the maintenance processes the part will be subjected to as it is repaired/reworked during the course of its normal life. Many items are routinely stripped and repainted or experience other indignities which could make a "permanent" mark disappear if it was ap-

plied with the wrong technology or in the wrong place.[24] Finally there is the challenge of documenting engineering decisions. Traditionally, all physical features of tangible hardware items are documented on the item's blueprint or engineering drawing. Each time the configuration of an item is changed, it is necessary to update the drawing(s). This would certainly apply to the addition of a DPM UII. If cost were no object, drawing updates would be of little concern. However, cost must be a consideration in UID implementation; drawing update policies, supported by adequate budgets, must be in place before wholesale marking begins.

DIRECT PART MARKING TECHNOLOGIES

DPM technology solutions take two basic methods: Non-intrusive and Intrusive marking, each with its strengths and weaknesses.

Non-intrusive Marking Methods

Marking methods that are non-intrusive to the material are produced as part of the manufacturing process or by adding a layer of material to the surface using methods that have no adverse effect on material properties. Popular methods include:

- Ink jet
- Laser bonding
- Laser Engineered Net Shaping (LENS)

Less common methods include:

- Silk screen
- Liquid metal jet
- Stencil
- Automated Adhesive dispensing
- Cast, forge, and mold

[24] It might, of course, be feasible to deliberately sacrifice the UID mark during rework with the intention of re-marking the item before it is reinstalled or released back into DoD's supply inventory. The next update to MIL-STD-130 (MIL-STD-130M) likely will permit the marking of items with a UID symbol that may not survive the overhaul/rebuild process. That may create a requirement to maintain the identity of a UID marked legacy item as it moves through depot processing, and to remark it with the original (the only) UII prior to the item exiting the depot. Complicating the solution is the need to avoid relying on key-entered data within that process. Routinely replacing UID marks should probably be avoided because, besides being expensive, it invites the introduction of errors.

General Comments about Non-intrusive Marking Methods

Depending upon the part to be marked, non-intrusive DPM methods are usually easier to get approved and implemented because material is being added to the part rather than being removed or deformed. Very little engineering analysis needs to be done to certify that the structural integrity of the original part has not been compromised, and this can speed up the DPM implementation process. However, UID part marking requirements include the factor of permanence of the mark - through both the operational as well as repair processes the part will go through over its lifetime – so that needs to be carefully considered in evaluating non-intrusive DPM methods. When adding material to the surface of any part, the surface may need to be cleaned to insure proper bonding, so extra time may need to be allotted to account for the particular part and/or process involved.

InkJet Method - Ink Jet markers propel ink globules from the printing head to the part surface. The permanence of the mark is dependent on the chemical interaction between the ink, the surface of the part, and other materials to which the part may be exposed, i.e., "cleaning solvents. Inkjet systems can be in a fixed station or fully portable installation with complete systems (hardware, software, installation) being in the $25-35,000 range.

Pros	**Cons**
• Fairly low-tech solution	• Durable only if protected
• Marking equipment can be portable	• Not good in abrasion or liquids
• Min. mark weight on rotating parts	• May not survive repair processes
• Computer-controlled, dynamic data	
• Quick, non-impact, min. jigs to hold	

Laser Bonding

Laser bonding is an additive process that involves the bonding of a foreign material to the part using the heat generated by a laser. Several kinds of lasers can be used: Nd:YAG, YVO_4, or CO_2. The materials consist of a glass or metal powder, oxides mixed with inorganic pigment, and a liquid base, like water. The material can be painted or sprayed directly onto the surface to be marked, or other methods

of application can be used. The process also can also be performed using a CO_2 laser and ink foils for use in less harsh environments.

Laser bonding is accomplished using heat levels that have no noticeable affect on metal or glass substrates and are safe for use in safety critical applications. The markings produced using this technique are generally resistant to high heat, or salt fog/spray and are extremely durable. Parts that go through repeated high speed physical stresses (e.g., high speed gears) should be life cycle tested to insure long term durability.

The consumable materials are inexpensive and the entire laser system can cost between $20-60,000, primarily depending the type and power rating of the laser itself. Most parts can be permanently marked with a lower power laser. CerMark is an example of this solution.

Pros	**Cons**
• Very durable solution, with-standing most operational and repair environments	• Equipment more expensive
• Best in fixed station with many smaller parts but equipment can also be portable	• Safety and training require-ments are higher
• 110v, low power CO_2 lasers generally sufficient	• Minor clean-up needed after marking
• Laser can make high quality marks in small areas	
• Quick, non-impact, min. jigs to hold	
• Computer-controlled, dynamic data on individual parts	

LENS – (Laser Engineered Net Shaping)

Laser Engineered Net Shaping utilizes the heat from a higher powered Nd-YAG laser to form a small weld-pool on the surface of the part to be marked. Simulta-neously, metallic powder is injected into the molten pool, building up a raised fea-ture (a dot). The injected metallic material can be a different material than the

part, and can be chosen to be corrosion resistant, wear-resistant, etc. LENS-deposited materials offer a rough surface finish, providing good light reflection.

LENS is compatible with all common steels, titanium, aluminum, nickel, and copper alloys, but gives a small heat-affected-zone in the part. LENS markings can be very durable, but the presence of a heat affected zone requires a more detailed engineering analysis if the part is in a highly stressed or safety critical environment. Prices are more in the $40-70,000 range.

Pros	**Cons**
• Very durable solution, withstanding most operational and repair environments	• High power Nd-YAG equipment is more expensive
• Best in fixed station with many smaller parts	• Safety and training requirements are higher
• 110v, low power CO_2 lasers generally sufficient	• Extra engineering stress analysis required for critical parts
• Laser can make high quality marks in small areas	• Powder delivery system makes equipment more expensive
• Raised material allows for easier reading of bar code	
• Quick, non-impact, min. jigs to hold	
• Computer-controlled, dynamic data on individual parts	

Intrusive Marking Methods (6)

Intrusive marking methods alter a part's surface (abrade, cut, burn, vaporize, etc.) and are considered to be controlled defects. If not done properly, they can degrade material properties beyond a point of acceptability. Consequently, some intrusive markings, especially laser, are generally not used in safety critical applications without appropriate metallurgical testing. Popular intrusive marking methods include:

- Dot peen

- Direct laser marking
- Electro-chemical etching

Less common methods:

- Engraving/milling
- Fabric embroidery/weaving
- Abrasive blast.

General Comments About Intrusive Marking Methods

Intrusive direct part marking methods need to be considered more carefully, especially if the part functions in a critical safety or dynamic environment. Intrusive methods alter the surface of the material, so localized stresses, heat affected zones, and micro-cracking need to be considered. On the other hand, many parts have been cleared to be vibro-etched with human readable marks using an uncontrolled, hand held machine. Those parts are likely candidates for intrusive DPM methods, which can be administered under very controlled circumstances as to depth, location, etc. and deliver the required data and bar code in a high quality manner.

Other factors to be considered when selecting an intrusive DPM technology:

- the reading of low contrast, grey-on-grey, bar codes requires relatively expensive readers for both the depot and the operating forces
- the mark has to be applied in such a location that it will not affect the integrity of the part
- the mark must survive manufacture, in-service, and repair processes over its entire life
- the cost of the marking equipment and the integration with legacy depot computer systems are non-trivial
- Intrusive DPM data and bar codes cannot easily be changed

Dot Peen Technology

Dot peening is the striking of a carbide or diamond tipped marker stylus against the surface of the material being marked. Because of the force required to indent

the surface of the material and the need for accuracy, the part generally has to held tightly in a jig to prevent it from moving. The stylus is driven by either compressed air or electromagnetic force. The depth of the mark is generally in the 0.003" range. Parts that were previously vibro-etched by hand are often good candidates for dot peening in the same general location (real estate permitting). Dot Peen equipment is fairly inexpensive, ranging from $10-25,000 in price.

Pros	**Cons**
• Very durable solution, withstanding most operational/repair environments	• Surrounding surface finish is critical to reading the mark
• Best in fixed station but can be portable if used with a clamp	• Extra engineering stress analysis required for critical parts (metals may be hardened at the peening site, potentially above Rockwell C)
• Low power requirements	• May not work on thin material
• Mark can usually be read under thin paint	• Possibility of special jigs needed to clamp part
• Compresses material in place rather than removing it	
• Computer-controlled, dynamic data on individual parts	
• Fairly inexpensive	

Direct Laser Marking

The laser works by directing a concentrated beam of coherent light onto a part surface. The marking beam is controlled via a high-speed computer that moves the beam by deflecting it off galvanometer-controlled mirrors. The movement of the laser can reach speeds of 2000 mm/sec with an accuracy of 0.01mm. The laser works by removing a small amount of surface material using heat. The possible presence of heat affected zones, micro-cracking, or other localized stresses needs to be considered by testing and/or engineering analysis.

Lasers come in several varieties - short, visible, and long wavelength lasers – which would be selected for their versatility and the kinds of materials which can be marked by each. Short wavelength lasers, also known as ultra-violet lasers,

utilize light in the lower end of the light spectrum and mark using a cold marking process. Lasers included within this category include excited dimmer (excimer) lasers. Short wave length lasers mark by removing material and are preferred for use in safety critical applications. Excimer lasers are used to mark extremely thin materials, wire insulation and very small parts. Visible wave length lasers utilize light in the visible light spectrum and produce marks using heat action or pressure. Visible wave length lasers are generally used to mark metal substrates. Long wavelength lasers, also known as infrared lasers, utilize light in the infrared spectrum and Carbon Dioxide (CO_2) lasers are included in this category. CO2 lasers are effective for marking organic materials such as wood, leather and some plastics.

Using a laser, many different techniques are available depending upon the material:

- Laser Coloring: Laser coloration is a process used to discolor metallic substrate material without burning, melting, or vaporizing the substrate material. This is done by passing a low power laser beam across a surface at slow speed to discolor the area of the mark

- Laser Etching: Laser etching is similar to laser coloring except that the heat applied to the surface is increased to a level that causes substrate surface melting. The advantage to using this technique on metal over laser coloring is increased marking speed. Excellent results can be routinely obtained at penetration depths of less than 0.001-inch.

- Laser Engraving: Laser engraving involves more heat than laser etching and results in the removal of substrate material through vaporization. This technique produces a deep light marking similar to a deep electro-chemical etch marking. The major advantage of this laser marking technique is speed, because it is the quickest laser marking that can be produced.

- Laser Shot-peening: Laser shot peen marking is a marking process for metal components that imprints an identification coding and leaves the surface in residual compressive stress.

- Laser-Induced-Surface-Improvement (LISI): Laser induced surface improvement (LISI) is similar to laser bonding except that the additive material is melted into the metallic host substrate to form an improved alloy with high corrosion resistance and wear properties.

- Gas Assisted Laser Etch (GALE): The gas assisted laser etch (GALE) technique can be used to mark an object in the presence of a selected gaseous environment, thus enhancing contrast and increasing readability. The mark is made using low power settings, enabling the mark to be made with minimal laser interaction with the target material.

- Laser Induced Vapor Deposition (LIVD): Laser induced vapor deposition is used to apply part identification markings, heating and defrosting strips, antennas, circuitry, and sun shields to transparent materials. This is accomplished by vaporizing material from a marking media trapped under a transparent part using heat generated from a visible spectrum laser.

It should also be noted that some of these same lasers may be used to create high quality data plates (e.g., AlumaMark) on demand (on the production line) rather than outsourcing that data plate creation to an off site source. This may offer added functionality or freedom that could not be considered before. Laser prices vary from $20,000 -100,000 depending on how exotic the selected laser technique is.

Pros	**Cons**
• Very durable solution, withstanding most operational/repair environments	• Surrounding surface finish is critical to reading the mark
• Best in fixed station with smaller parts but other options available	• Extra engineering stress analysis required for critical parts
• Very high quality mark	• May require extra safety equipment and training
• Computer-controlled, dynamic data on individual parts	
• Can be very fast	

Electro-Chemical Marking: Electro-Chemical Etching (ECE) removes metal from a metal object by electrolysis. The mark resulting from this process is the least likely, of all the intrusive marking methods, to weaken, deform, or fracture the metal beyond the marking depth. Only the molecular structure involved in the mark itself is altered (removed). Marking is accomplished by including the part to be marked in an electric circuit, and applying a DC potential across an electrolyte separating the part and the applicator electrode (essentially a sponge soaked in electrolyte). Metal is removed from the part and transferred to the applicator pad. The shape/pattern of the mark is determined by a pre-made stencil, which can be created by a desktop, computer-controlled, thermal transfer printer. All conductive metal parts can be marked by this process. (Anodized parts, normally considered insulated by the anodized coating, can also be marked.) Etching depths can be precisely controlled and range from 0.0001 to 0.01 inches. Materials as thin as

0.001" can be etched. Following etching, the part may be anodized and/or protected with clear coatings.

Though not lengthy, this is a very manual process and is best suited for individual piece parts as a new stencil would need to be created for each new serialized part being marked. It is inexpensive, with the equipment costing between $5,000 - $12,000 for the Chem Etch equipment, the thermal transfer printer, computer, and stencil material.

Pros	**Cons**
• Inexpensive	• Operator technique is an uncontrolled variable
• Fairly low-tech approach, minimal training	• Not allowed on certain safety-critical parts by some manufacturers
• Can be done completely in-house	• Doesn't work on non-metallic parts
• Best for one or two parts, versus a long production run	

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VERIFYING MARK INTEGRITY

Using DPM technology to apply a 2D UID data matrix to a part is only part of the challenge – reliably reading the mark, especially in the field using hand-held equipment, is of equal concern. Most of the DPM solutions create a bar code mark that provides only a low contrast differential from the surrounding material – a grey-on-grey situation – and for an optical technology like the bar code this can make reading difficult. A depot which marks the part when it is new or newly repaired must have an appreciation for the field maintainer's circumstances when the part is in-service and dirty. Therefore, an integrated quality assurance system of direct parts marking and mark reading in real world conditions has to be devised before beginning wholesale making. The system must be robust, standardized and able to endure for many years in actual service. This is a relatively minor concern for most depot manufactured items, but will be an enormous challenge to maintenance managers tasked to mark and read legacy parts.

Engineering Drawing Changes

Another difficult task the Engineering WIPT will have to deal with is how to handle the engineering drawing change process. Establishing one or more internal part marking standards and templates that can be referenced across many different

parts will add to the ease and consistency of changing drawings and marking parts. A number of DoD Suppliers have already traversed this path and are willing to share what they have learned with others. The effort to develop an internal part marking standard that can be referenced repeatedly will be worth the effort if the depot has more than a few drawings to change. Collaboration on this phase, with other engineering activities, OEMs, or other Suppliers will speed up this effort considerably.

Engineering Analysis Summary

The engineering capabilities needed to determine how and where to apply a UID mark may be found in the depot's Materials Engineering Laboratory or similar facility (if one is present). Engineers in the Materials Labs typically have the knowledge, skills and equipment needed to make informed UID marking decisions. While these engineers may or may not be the same individuals the PMO has designated as "cognizant technical authority" (CTA) for the equipment and parts under consideration, they will surely be able to contribute to the Engineering WIPT's efforts. The problem is limited capacity which may not gracefully scale to the size needed to support a large variety and quantity of legacy UID items.

As parts marking workload increases, engineering analysis could become a bottleneck if engineering capability and capacity are not planned carefully (Figure 2-5.).

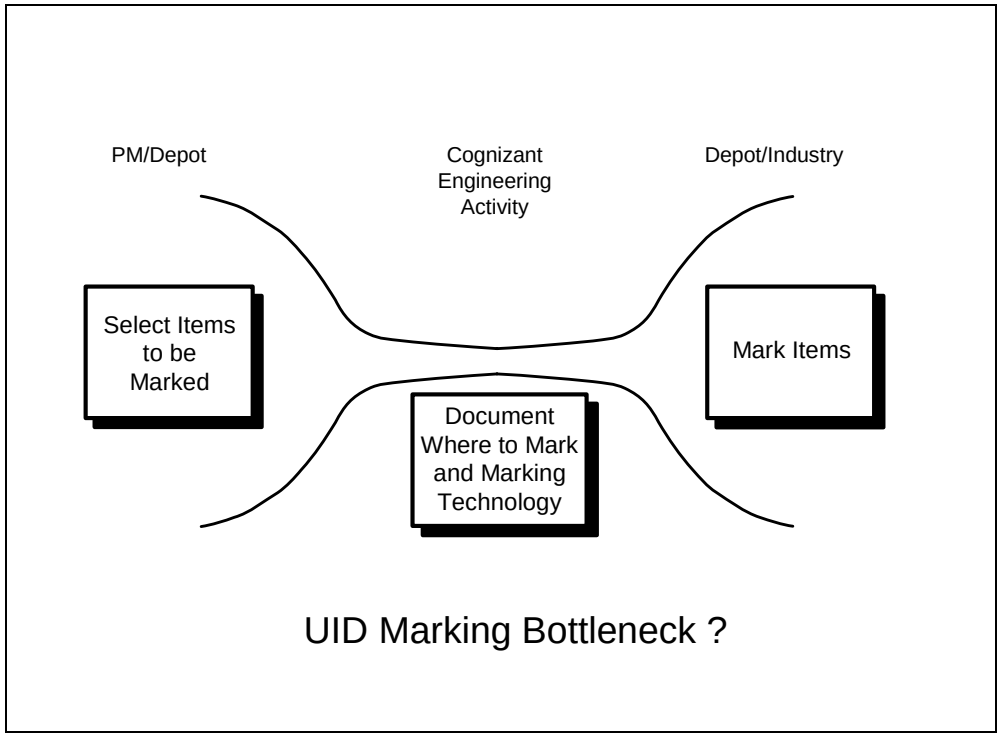


Figure 2-5.

Critical Collaborative Tasks

In addition to the primary responsibilities just discussed, the UID Engineering WIPT must collaborate closely with the AIS/Database WIPT and the Depot Production WIPT in a number of critical areas. Included among these areas are:

1) Understanding UID, Serial Number Tracking (SNT), and Serialized Item Management (SIM) functions and goals
2) Designing a generalized Serial Numbering schema that:
    a. Meets Engineering's goals relative to the above policies and internal needs
    b. Appropriately handles both Construct 1 and Construct 2 serial numbering schemas, whether they use the Spec 2000 approach (TEIs), the MH10 approach (DIs), or the EAN.UCC approach (AIs). This schema has to work for both new and legacy part marking situations without serial number conflicts occurring.

UID implementation opens a whole new era for sustaining engineers to more easily capture accurate and timely data on the equipment for which they are responsible. With UIIs in place to permanently identify individual parts, traceability during operational and repair cycles will become much easier, dramatically improving visibility into the life-history information needed to make better and faster engineering analyses and support decisions.

Cost of Alternative Marking Technologies

An engineering-related challenge is the issue of marking hardware (and software) cost at the depot. As discussed previously in this chapter, the alternative marking technologies are going to have different non-recurring and recurring costs. These costs need to be considered as a preferred marking alternative is selected for each UID application. Parts marking cost analysis is a business decision that will become activity-specific over time. The process will start, of course, with parts marking guidance already reflected in existing technical data packages and/or Military Specifications such as MIL-STD-130L (Appendix F). However, it is unlikely that current data packages and policy guidance will adequately address the entire UID DPM challenge. New processes will be needed in the organic depots. As investments are made in new marking equipment and new artisan training at each depot activity, and as marking workload increases at that depot, the marginal increased cost of using the new equipment and the new capability declines. DPM processes at a given depot will preferentially capitalize on existing equipment and training. Resident capabilities will, over time, influence the selection of marking technologies for future parts.

Considering the requirement for both engineering and cost analyses, the following plan is suggested:

Engineering and Cost Analysis Strategy

For items which already have a label or label plate (details specified on the drawing or DMWR), add the UII to the existing label using the current marking technology. No significant engineering analysis is required. For all other items, task[25] the Cognizant Technical Authority (CTA) to analyze the part and designate one (or more) suitable marking location(s) and one (or more) suitable marking technology (ies). The preferred technology will normally be a new label or label plate, real estate and operating environment permitting. If direct parts marking (DPM) is required, and the CTA approves more than one location/technology, the prime DOP shall select the preferred location/technology based upon life-cycle marking cost. Cost analysis is the responsibility of the prime DOP, and shall always be the cost to the Government of both non-recurring and recurring marking activity, and non-recurring and recurring UID data management activity. If more than one DOP repairs the item under consideration, the prime DOP is obligated to select from among the CTA-approved marking locations/technologies the combination which minimizes the total cost of marking, not just the cost born by the prime DOP. Once a DPM location/technology has been selected, that selection becomes the only approved location/technology for that part, and will be the selection documented in the drawings/specifications/DMWRs. Under no circumstances will the same part be marked in different locations or with different technologies by the same or different DOPs.[26]

UID AIS/DATABASE WIPT

For several years the depot AIS/database aspect of the UID Policy has been undervalued relative to the importance, difficulty and complexity of the task. Assumptions and statements that "the computer system" will handle certain aspects of incoming UID data ignore the fact that there are thousands of different computer systems across Suppliers, Distributors, and the DoD itself, and virtually none of them has been re-programmed to align with the requirements of UID and SIM Policy. There are several architectural solutions to this problem, and these will be presented later in this section. The complexity of the AIS/database issue is caused in part by the broad range of alternative solutions involved: new, modify, or bolt-on system changes, short term vs. long term, centralized vs. decentralized systems and data, business cycles, changing business processes, and entirely new features of systems interfacing with computerized marking machines on the depot

[25] The task will usually be in the form of a funded work request if the CTA is a Government laboratory, and a purchase order or contract if the CTA is a commercial laboratory.

[26] An important additional planning consideration involved legacy parts which may still be in production (e.g., a spares reprocurement). If the commercial vendor has already done the engineering, selected a technology and location, and marked some quantity of new parts, the DOP must mark his legacy parts in the same location using the same technology.

production floor that require entirely new thinking. Not the least of the problems involve the fact that the depot needs to keep functioning effectively (and, hopefully, efficiently) while all these AIS changes are being made!

Business Practice and Business Direction

One of the most difficult things for technical AIS and database people to understand is the fluidity of business changes. Business and computer programming often involves conflicting requirements and assumptions – one capability needs to track quickly with what the Customer needs and other business realities, and the other is supposed to codify the business rules into a standard, repeatable process.

The UID AIS/database WIPT needs to balance the desire for "maximum flexibility" with the need to deliver a workable solution in the short term. Several foundational concepts are key in meeting this need:

Understanding the Business and the Business Direction

It is mandatory that the AIS WIPT understand the current depot business environment, where requirements are going in the future, and the parameters that cause MRO and manufacturing requirements to change. Some parameters change very slowly, others change quickly. Designing solutions in the near term with an eye for the long term business base is an important concept. Core depot workload is relatively stable, but methods of input, output, interfacing and reporting change regularly. The UID AIS should be designed with modularity in mind so that the core business logic does not get disrupted every time a depot policy or reporting requirement is updated: hierarchical vs. relational databases, wired vs. wireless access, dedicated network vs. Internet, 3270 CRTS vs. web browser user interfaces, the old security package vs. next year's security package – these are all parameters that should be designed to be as modular as possible.

Despite recent trends in the ERP world to 'simplify' the manager's life by centralizing everything in one system, history and wisdom have shown the need to maintain some independence and some degree of control over the data formats that go into, and come out of, such all-in-one solutions. This requirements also "plays well" with future business applications that don't exist in the baseline ERP suite of solutions. Figure 2-6 shows an example of a modular AIS design that offers flexibility for the depot to migrate into the future:

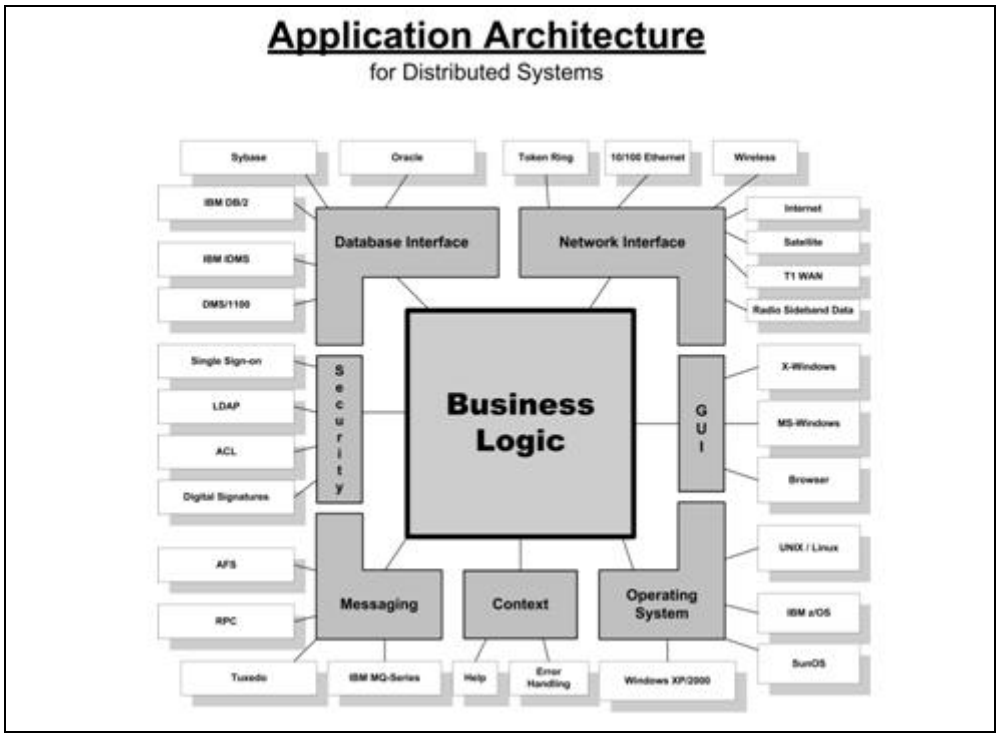


Figure 3-6

Understanding the Technology Changes

Technology changes constantly – business functionality does not. Modifying or designing systems to isolate technology changes from the core business process is a key concept for a successful UID/SIM AIS. Whether the data is coming into the AIS on a floppy disk, a USB memory stick, or as a data feed on a sideband of an XM Radio transmission, handling the data properly *within* the AIS changes very little. The same applies to data entered into the system via keyboard typing, linear or 2D bar code optical scanning or via an RFID chip - all forms will likely need to be accommodated by DoD's depots for several decades at least.

Another powerful concept to consider here is the ongoing change of "isolated and stand-alone" systems relative to "connected and collaborative" systems. The systems design landscape is into its third generation since the computer age dawned in the 1950s. It has changed from internal only, to internal with asynchronous file transfer, to real time connection and collaboration. With UID-enabled pedigree management, the depot repair technician will know as much as the PMO Logistics Manager or the cognizant sustaining engineer about an incoming part's current reported defect, configuration, failure history and maintenance record. A maintainer in the field can know as quickly as the depot workload coordinator where his materiel is in the repair/rework process and when it will be completed. This

kind of visibility and collaboration will reap huge rewards, and also create some new demands.

Defining Data Standards

One of the foundation on which depot effectiveness and efficiency is built is data. Data is persistent across time, across changes in leadership, and across technologies. Defining "your own" data has been a standard management practice for decades, but in this third era of inter-connected computer systems (to say nothing of future "network-centric" eras), that practice is no longer appropriate. There is a core set of data surrounding the physical part – Manufacturer Code, Serial Number, Part Number – that is needed by everybody who touches the part, and even by many who don't. These are the "birth record" data elements encoded in the UII as required by UID Policy. But there is also all of the data needed by all of the functional disciplines which collectively make up the end-to-end DoD materiel readiness value chain (materiel acquisition, materiel distribution, materiel supply support, materiel maintenance and materiel sustaining engineering). While the depots never have been independent and isolated from the rest of the sustainment value chain, their function in the future is likely going to be even more open and accessible. In support of "network-centric" warfare, "knowledge-enabled" maintenance will use data to ensure that quality weapon system support is as rapid and agile as the operational missions it sustains. This data cannot be the depot's data, or the warfighter's data or Headquarters' data. It's just data - useful to everyone because it is in a standard format. It is for this reason that defining universal UID data standards, and employing the standards with discipline is so important

In the era of computers and databases, common, minimum data standards are needed that address both the human factors and collaborative data issues. Definitions are needed for things like the min/max field length, whether the data is alpha, numeric, or both, and what special characters are allowed in the data fields (for instance, are commas, periods, parentheses, or forward/back slashes allowed in a Part Number field?). Years of history of people reading small-sized Part or Serial Numbers off data plates have produced some common sense guidelines that help avoid human misinterpretation of the data. Keeping in mind that the depot which marks a part may have wide latitude in data composition, below are a few common problems to avoid in order to improve the accuracy and acceptability of the Part Number and Serial Number data across many different systems:

Avoid:	**Reason – people or computer**
- alpha I, O	- misread as 1 or 0
- lower case letters	- often misread; some systems can't accept

- period, comma decimal	- often not seen; system may stop reading at
- forward/back slashes	- misread as 1s; system interprets as end-of-data
- parentheses	- unclear if the actual number, or indicates a subset value like the modification of a Part Number

The most common and easily seen (people) and understood (people and computers) special character used as a delimiter is the dash (-) character, and should be the only special character considered when creating any new Part or Serial Numbering schema. The issue is not what <u>your</u> depot system or people can accept but what is most acceptable data across the hundreds or thousands of systems your parts will be transacted in over the next 20+ years.

Some Commercial standards (e.g., Spec 2000) have clearly defined data for common usage, with an XML option, but the military has yet to accomplish that. The time is past for one-to-one data sharing arrangements with each individual company or database. A core set of common data elements will allow a many-to-many collaboration to succeed. Though a single depot may not be able to affect such data standards across all DoD operations, a single depot and its supporting UID Engineering WIPT and AIS/database WIPT can begin to move in the right direction and define some standards for these key data elements, and then continue a standards dialogue throughout the larger community.

1) Serial Numbers on parts should never be modified, or all hope of identification and traceability is lost. If the "form, fit, or function" of the part is changed, then the Part Number is modified to reflect that change for configuration control purposes. If other changes are made, sometimes a "Mod" status is changed. But the Serial Number should never be modified because computers don't look for Serial Numbers that are "pretty close" to being the same number.
    a. An exception to this standard practice occurs if a part is being "reborn" with a new, unique UID Serial Number used in Construct 1 scenarios while marking legacy parts. Then a Traceability Database records the original serial number and the new permanent, UID Serial Number so linkage can be made to historical records via this lookup table.

2) Specific to the task at hand, the AIS/database WIPT needs to understand the purpose and direction of three dominant DoD policies: Unique Identification, Serial Number Tracking, and Serialized Item Management. These are key business drivers for the transformational effort now being undertaken. It is not sufficient to just understand what *your* depot needs since in this collaborative, connected world an increasing number of busi-

ness drivers will be coming from outside the depot's immediate span of control.

3) Another consideration under this category of defining data standards involves the use of Extensible Markup Language (XML) data tagging. The DoD has a policy on the use of XML that goes beyond the scope of this discussion[27], but the concept of making the data intelligent, as specified in UID/SIM Policy, is a powerful concept indeed. Not all the data formats allowed by the UID Policy are XML-compatible, but selecting the right format can open many doors of opportunity for expanded benefits that come with transparent data sharing within the depot's other systems, the other military Services, and with commercial Suppliers as well. It is recommended that the XML tag be stored with the data, otherwise the intelligence will be lost when data is exchanged with other systems. This will require a little more space in the database, but storage space is very inexpensive, the XML tag can always be stripped off by some system that can't handle it, but the chance to avoid data mistakes will become increasingly important as data flows from system to system without human intelligence interpreting/mapping/converting it. Any time a human gets involved in the data flow, the cycle time increases by 3, 4, or 5 orders of magnitude, and the possibility of transcription error increases dramatically. Such inefficiency is no longer affordable when well-defined, common, XML-tagged data can flow automatically whenever communication is required.

4) **Database Security/Data Integrity** – Once having a UII for a newly manufactured or legacy UID part, it is extremely important that neither the UII, nor any of the data that makes up that UII, be allowed to change. To do so would immediately disconnect the data from the physical world and many data records in other systems which rely on the UII to accurately point to a unique tangible asset could never be connected again to the proper piece of equipment or part. Data security protocols (record locking or data field locking) need to be implemented to protect the integrity of the UII.

   There also need to be business processes established to decide how the people, and the AIS, will respond when they encounter duplicate data, bad data, or missing data. The currently popular military practice of simply deleting any duplicate data found in the database ignores the reality that there may be two parts that have, in fact, similar data plates. Or the database records appear to be duplicate at first glance, but one record is clearly more accurate than the other, and the good record should not be deleted.

[27] See Policy for Registration of Extensible Markup Language (XML); 22 April, 2002, Office of USD(AT&L)

In an existing legacy UID marking project with just thousands of parts being given UIIs, there have been live examples of all these problems through process mistakes and normal human error. Mistakes and errors will always happen, so the solution is to build into the AIS some level of error checking and/or error flagging to trap errors before they get into the database and get passed on to other databases. The cost of bad data is very high and the only practical way to fix that problem is to stop it at its source. The entire UID initiative is the DoD's response a documented lack of data integrity in its own databases. The explicit Department goal to achieve a "clean" PP&E audit opinion by FY 2007 requires that integrity be restored to the data under consideration. UID changes to the tangible asset inventory AIS and to the discipline with which inventory and financial accounting business process are implemented provides the unique and fresh opportunity to restore (and retain!) asset accountability.

Business Process Analysis

Several aspects of UID capability establishment are encompassed in this phase. First, at a high level, the "as-is" process by which the depot executes its MRO and manufacturing mission needs to be understood (hopefully this is already document somewhere). Second, based on the requirements and directions of the UID, SNT, and SIM transformations, plus other internal desires to improve the depot process, a "future state" of the AIS/database functionality needs to be defined. Third, a "gap analysis" needs to be conducted to quantify the difference between "what is" and "what should be".

With the depot having a sense of where it is and where it wants to be to remain relevant in a network-centric & knowledge-enabled maintenance future, the next step is to examine alternative process improvements needed to achieve the vision end state. UID provides some exciting options not otherwise available:

1. Automated, centralized, control and feedback of the uniqueness of the Serial Number either assigned to a part or read from an existing UID part. This may involve geographically distributed operations, so the analysis of distributed versus centralized data and computing resources, and the selection of appropriate Serial Numbering schemas are important. It also may involve maintaining real time, online, internal databases and/or tapping into the UID Registry and/or other designated Service data bases holding item pedigree information (i.e., SIM data bases) in real time. Examples might be when a UID component from an outside Supplier is incorporated into a depot-repaired product, the depot is now responsible for the UID data of the whole product, including reporting to the UID Registry/SIM data base the new parent-child pedigree of the repaired part.

2. New computer interfaces for workers on the production floor. The biggest change may be the data and communication links to automated

part marking equipment on the production floor, but there will also be additional AIT and data input requirements as UID-labeled assets are uniquely tracked, processed, and reported on to a level of detail not here-to-fore possible.

3. External and dynamic data interfaces to suppliers' computer systems, customers' computer systems, and the UID Registry/SIM data base, along with the necessary security and authentication processes in place.

The good news is that these key factors are not needed just for UID compliance. They are foundational practices for the digital, collaborative business environment of the future. These concepts also directly support the high-level initiatives that comprise the overall Defense Transformation effort within the Department.

Architectural Solutions

Before a system architectural option is chosen at the depot, it is very important to understand the major changes that UID, SNT, and SIM are demanding, initially for newly manufactured parts and now for all legacy parts that need UID marking and tracking in databases. This is a significant paradigm shift from the way things were done before, and the depot's systems need to be prepared to track with these changes.

The fundamental change is that the depot AIS applications need to capture the various UII data elements, combine them into a correct data string (which requires understanding the new UID business rules), and store the 78-character (maximum) UID Number in its own database. Whether buying new, buying "bolt-on", or changing the depot's legacy AIS, significant and major database reconstruction will be a major part of any depot UID implementation. The UII becomes the key, the index, the primary cross-reference number that links information about that part across many different decision support systems. It is the 'social security number' for that unique part, and will be the means by which the part is tracked throughout its life.

The other very significant change is that all tangible assets which require a UII (equipment end items as well as spare and repair parts) now have to be marked using a computer-controlled process – no longer will hand stamping, vibro-peening, or hand lettering be acceptable. The minimum requirement for UID marking is a two dimensional (2D) Data matrix bar code symbol that can only be applied via a computer-driven marking machine. This interface between the controlling computer and a new, production floor marking machine will create significant changes to existing processes. An example of this computer control is depicted in the "bolt-on" system in Figure 3-7.

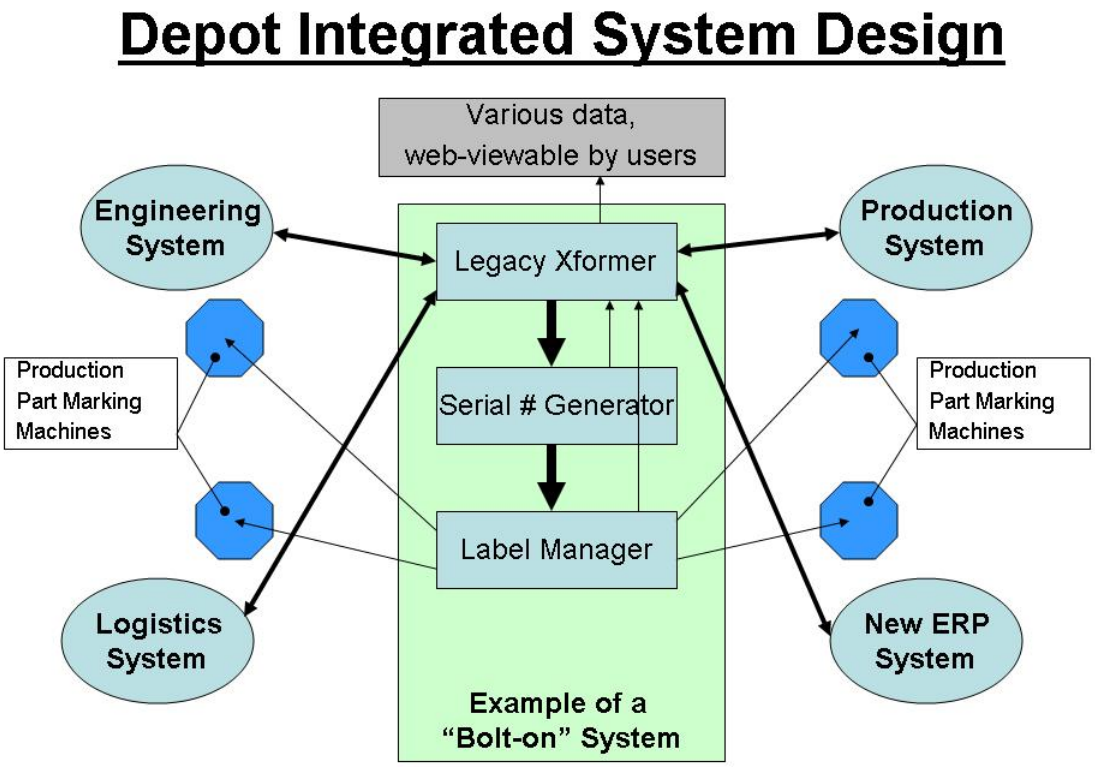
Assuming each depot has a legacy AIS system in place, three options are available for going forward:

1) Replace legacy system(s) completely
    a. This is a costly and usually lengthy process, which may be the right answer in the long run, but cannot be practically achieved in the short term.

2) "Bolt-on" new functionality to legacy system(s)
    a. This option allows for a quantum leap in functionality to achieve the UID and SIM objectives, with varying degrees of modification to legacy systems. Such modifications may be accomplished in-house or outsourced, on the existing legacy hardware or on an entirely new server that could be plugged into the depot's network. The "glue" that makes this option work is the real time sharing of common data between the legacy and the bolt-on system. A graphic example of this type of solution is shown in Figure 3-7.
    b. Two variations on this theme will be presented:
        i. Use the new bolt-on system as the primary user interface, where necessary data is both collected and sent to the production floor via this new user screens, retained in the new database, and appropriate data is also passed through to the legacy systems so that all previous accounting, reporting, and control functions continue as before
        ii. Use the new bolt-on system as the primary database, port existing data into that database, and modify the legacy system(s) to utilize the new database functionality based on the UID functionality of this 'social security number' concept.

    Re-mapping legacy databases into some other form is usually a non-trivial exercise because there are many different applications that access the data in those databases, so those applications may need to be changed as well.

3) The third architectural option involves making significant modifications to the current depot legacy system(s) to align with UID and SIM objectives. This is a very viable option if the system(s) are currently meeting all the business needs and are flexible enough to change into the future with UID, SNT and SIM requirements. This would probably be the least expensive option assuming both knowledgeable IT and business resources are available. It would also be least disruptive (changes, re-training, mistakes, etc.) to the depot's business process.



Example of How a "Bolt-on" System Works with Existing Depot Systems

Figure 3-7

This past discussion was predicated on the assumption that the depot currently has an adequate AIS to control its operations. If no AIS is in place, or it is so inadequate that it can be ignored, the opportunity to respond to the UID/SIM AIS requirement with a new solution opens doors that are unavailable to depots with legacy systems, and UID implementation becomes, in many ways, much easier.

Serial Number Schema Control

There are a number of parameters that go into the decision of how to create a new UID Serial Numbering schema, and these will be discussed shortly. But two over-arching statements can be made that encompass the most important considerations:

1) Serial Number uniqueness must be controlled across the organization.

2) Regardless of how the depot choose to mark their parts, their AIS systems must accommodate all the UID variations allowed by the Policy –

both Construct 1 and Construct 2, in either TEI, DI, or AI formats, for both new and legacy parts.

These two statements will be discussed in some detail here, and then further discussion will deal with secondary issues.

The Serial Number must be unique within the issuing organization's authority or span of control. This is true regardless of whether the organization chooses to serialize using Construct 1 or Construct 2. Ensuring such uniqueness requires planning. Does the depot have the only controlling authority on the Serial Number, or might another depot, manufacturer, or engineering organization think they have controlling authority? Clearly establishing who has authority for the uniqueness of the Serial Number is a necessary first step. Authority is delegated to the organization which applies its Enterprise Identifier (EID) on the part. Major problems will occur when organizations (Engineering vs. Production) or facilities -- be they another part of the building, another building in the depot, another depot under the same command, another computer system, or a third party Supplier who is delegated responsibility to use a CAGE Code – do not either know of each other or who do not carefully coordinate their Serial Numbering schemas. Multiple points of control will not be successful and cause significant re-work of expensive parts to occur - the UID Registry will not allow duplicate UID numbers!

Several solutions do exist. The Serial Numbering schema must be organizationally controlled, but the final Serial Number and the actual marking of the part can certainly be accomplished in a distributed fashion. This allows flexibility to design the UID/SIM AIS to accommodate the new and the old, the centralized and the distributed organizations, and outside Suppliers who may be marking parts for the depot. A simplistic example of this would be to have your Alabama facility start uniquely serializing their parts starting with an 'Axxx', the Boise facility use a 'Bxxx', etc. As long as some central organization controls who can mark Serial Numbers beginning with 'A', there should not be a problem. Other creative numbering schemas are mentioned later, but organizational control of Serial Number uniqueness is mandatory, should be documented, and widely understood across the organization.

Serial number mistakes can, and will, happen so it will be important to design into the process the proper checks and balances to insure that mistakes are caught early in the process and corrected. The cost of finding, and then fixing, the mistake increases by an order of magnitude each time the part is physically moved to another area of responsibility with a bad/duplicate UII on it. Retrieving the part to mark it correctly, marking it again, and correcting bad data in the primary database (i.e., the UID Registry) and secondary data bases (e.g., Service SIM data bases) are huge expenses to the marking organization. The secondary effects on materiel inventory managers and weapon system sustainment managers who depend on good UID data are not even considered here. Accordingly, an automated check and affirmative feedback loop on Serial Number uniqueness is strongly recommended to avoid serious costs and delays.

If the designated marking organization employs a centralized AIS which integrates its serialization activities, then controlling the Serial Number will not be a big problem. If the control of Serial Numbers is currently done manually, or automated but handled differently in different facilities, then a tailored serialization approach will be needed.

Serialize Using Construct 1 or Construct 2

Affecting the serialization control, to some degree, is the depot's choice of using either Construct 1 or Construct 2 numbering schemas. From the UID support material (***DoD Guide to Uniquely Identifying Items***), comes a Table showing the data elements making up the two Construct approaches (Figure 3-8):

Create and Generate the UID

The components that make up the UID are identified in the table below. Each enterprise has two options for creating the UID. *These are constructs*

	UID Construct #1	UID Construct #2
Based on current enterprise configurations	If items are serialized within the Enterprise	If items are serialized within Part Number
UID is derived by concatenating the data elements IN ORDER:	Issuing Agency Code* Enterprise ID Serial Number	Issuing Agency Code* Enterprise ID Original Part Number Serial Number
Data Identified on Assets Not Part of the UID (Separate Identifier)	Current Part Number	Current Part Number

*The Issuing Agency Code (IAC) represents the registration authority that issued the enterprise identifier (e.g., Dun and Bradstreet, EAN.UCC). The IAC can be derived from the data qualifier for the enterprise identifier and does not need to be marked on the item.

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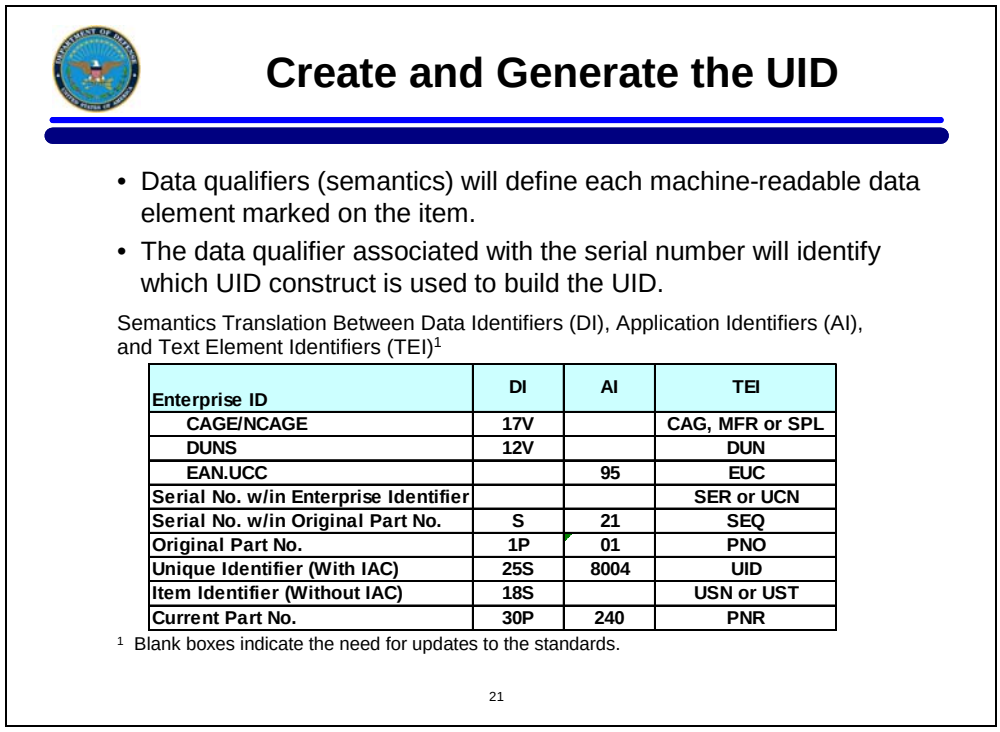
Figure 3-8

Note that the Current Part Number is never a part of the actual UII data string, but is always needed on the part for general identity, configuration control, re-ordering, etc.

Construct 1 is considered superior in terms of simplicity, smaller numbers, reduced marking space required, and fewer data entry mistakes made during regular usage, maintenance, and repair. Construct 1 involves only one logic-level for checking – is the Serial Number unique within the Enterprise Code?

Construct 2 is slightly more complex, requiring two logic-levels – Serial Number unique within the Part Number, and Part Number unique within the Enterprise Code. The Construct 2 approach is often times the way serialization was conducted in the past – serializing within Part Number. It is also part of the reason why the current state of tangible asset inventory management is such a mess! Companies or depots would serialized within Part Numbers, but then modifications changed the "form, fit, or function" forcing a Part Number change, and the Part Number/Serial Number identity of the part would be lost. To a computer, part number ABC is not the same as part number ABC-3. This "logic gap" was corrected in the UID Policy when OSD specified that the Original Part Number, which never changes, must be used to create the actual UII data string. The risk with using Construct 2 is that old habits, old thinking, and old processes that miss the subtlety of using original versus current Part Number will continue to cause problem into the future. Careful avoidance of that confusion will allow Construct 2 approaches to be successful.

Regardless of which method a depot chooses for marking its legacy parts, both Constructs have to be supported in the AIS (as specified by the UID Policy) in order to read and manage the parts that come from a variety of sources outside the depot's control. There are over 50 different UID format options that the depot UID AIS needs to be prepared to handle, encompassing two constructs, new and legacy part marking, across three main data format schemas (TEIs, DI, AIs), with additional options for marking very small parts, and possibly including "UID Equivalent" designators (e.g., vehicle identification numbers [VINs]). Figure 3-9 reflects the array of possibilities.



Create and Generate the UID

- Data qualifiers (semantics) will define each machine-readable data element marked on the item.
- The data qualifier associated with the serial number will identify which UID construct is used to build the UID.

Semantics Translation Between Data Identifiers (DI), Application Identifiers (AI), and Text Element Identifiers (TEI)[1]

Enterprise ID	DI	AI	TEI
CAGE/NCAGE	17V		CAG, MFR or SPL
DUNS	12V		DUN
EAN.UCC		95	EUC
Serial No. w/in Enterprise Identifier			SER or UCN
Serial No. w/in Original Part No.	S	21	SEQ
Original Part No.	1P	01	PNO
Unique Identifier (With IAC)	25S	8004	UID
Item Identifier (Without IAC)	18S		USN or UST
Current Part No.	30P	240	PNR

[1] Blank boxes indicate the need for updates to the standards.

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Figure 3-9

Array of Solutions for Creating Serial Number Uniqueness

At first glance, it may appear that in order to meet the UID mandate, most depots will have to create something entirely new - a capability that does not currently exist. Hopefully that won't be necessary. Whether marking new or legacy parts in the depot, modifying the Serial Numbering schema is much easier than usually imagined. These kinds of changes are considered "soft" changes that require more of a change in thinking and assumptions rather than any real process change. It may, however, take a little creative thinking on how to create a unique Serialization schema that works with current business rules and existing systems.

A concern often expressed is that the depot will run out of Serial Numbers. UID Serial Numbers can be alphanumeric and up to 30 characters in length (though shorter numbers are encouraged). Excluding from consideration all the "problem" characters like I, L, O, Q, Z, etc. there are still about 31 alphanumeric characters that are available. Each of the 30 Serial characters has 31 choices to fill it, providing approximately 30 to the 31st power of possibilities (30^{31}) – there is no name for the magnitude of Serial Number possibilities that represents!

It should also be noted that any Construct 1 serialization schema (unique Serial # within EID) is automatically compatible with a Construct 2 approach. If the Serial

Number is unique within the EID it is also unique within the EID and Original Part Number; the reverse however is not true.

Shown below are a number of suggestions for how the numbering schema might be implemented. The suggestion that works best for one depot may not be the best for another (this is probably not something that needs to be standardized among depots, but, of course, an individual depot's choice must remain constant over time...).

1) Start **Serial #**s in a higher numbering range than has ever been used before (e.g., 999xxxx)

2) Start **Serial #s** with an alpha character(s) that have never been used before (e.g., Nxxxx)

3) Change the basic format of the new, unique **Serial #s** (e.g., N-xxxx)

4) Start the **Serial #** with current year so that every year the trailing numbers of the **Serial #** could be 'reused' (e.g., 2004101, 2004102, 2004103,… next year 2005101, 2005102, etc…).

5) Start the **Serial #** with a 2-digit year to make the overall number shorter (e.g., 041, 042)

6) Start the **Serial #** with a 2-digit year and 2-digit month (e.g., 04071, 04072) allowing the trailing numbers to be 'reused' every month.

7) Use a year-month-day format to start **Serial #s** (e.g., 040729100, 040729101, etc.). These numbers won't repeat for 100 years, but then you'll have a problem; or use 20040429100 using a 4-digit year to avoid all confusion. [Be aware that some industry standards may have upper limits to how long the number can be, like 15 characters max.].

8) If you currently serialize within **Part #**, use a unique portion of that **Part #** as the beginning of a new Serial numbering schema and continue with your current serialization schema. For Part family "A", continue your serialization schema but now prefix the **Serial #** with an Axxxx, or an A-xxxx, or an AAxxxxx. The end result must be that whatever **Serial #** you end up with has to never have been used before within your EID Code and must never be used again. This includes other product lines, other divisions, or other factories within your company which might use the same corporate EID Code.

9) Request a new EID Code, and thereafter only use centrally-controlled unique **Serial #** assignments with that EID Code.

10) Suffix your current **Serial #** with a unique portion of the **Part #**

11) If a unique portion of a **Part #** cannot be determined, or if the unique portion of the **Part #** and the **Serial #** are too long when combined together, create a translation table for the given **Part #**. Use that 'alias' instead of the actual **Part #**. (e.g., Part # ABC12873645X4 = alias of "P12" – new unique Serial # can be P12101, P12102, etc)

One goal in this effort is to make the Serial Number as generic as possible. This will provide the maximum amount of flexibility in the future. If the Serial Number is made too intelligent (e.g., "the 10th character always means…"), it will constrain flexibility and you may "run out" of numbers following that specific line of intelligence. The options in the list above are only examples; a little creative thinking may reveal a superior solution for the depot's particular problems, process, and people that need to be accommodated.

In general, it should also be stated that numbers that people have to deal with (Part Numbers, Serial Numbers, etc.) should be as short as possible. If people ever have to read them correctly, the rule is:

Size does matter:

The shorter the better

For the next 5-10 years, the majority of people handling parts will still be reading and typing the data into computers, so the fewer characters people have to read and type, the quicker and more accurate the data will be.

Other areas that mirror Best Commercial Practices that involve people interacting with computers include:

- Not making numbers very intelligent (if the 10th character is a Z, then the bearings came from Supplier X…)
    - nobody but a few engineers understand, or care about, the intelligence behind the numbers; that's what computers are good for – to look that information up and display it in understandable form.
- Not padding Serial Numbers with leading zeros
    - makes it difficult for people to accurately count 6 leading zeros
    - though <u>your</u> Serial Numbers may be numeric only, Serial Numbers in general are alphanumeric string of characters – not numbers – and one or more leading zeros will change the Serial "Number".
- Not padding data fields with blanks, spaces, or tab characters
    - On paper, these characters are not obvious and can be ignored when copying; in bar coded data fields, however, they are actual characters, even though they are unprintable (invisible).

Strategy for Legacy Part Marking

The depot should select a strategy for building UIIs for their newly manufactured items first, being a simpler case, and then test that logic against marking all their various legacy items. Two approaches are available for marking legacy parts:

1) using Construct 2 and verifying uniqueness item by item, or

2) re-serializing parts when they are made UID-compliant, to become Construct 1

The problem comes because legacy items have existing Serial Numbers. These would be good to retain for historical reasons, so Construct 2 might be a good choice. To be UID-compliant, however, the original Part Number must be used if Construct 2 is used to create the UII . Potential problems with this approach are that previous business practices were so sloppy that duplicate Serial numbers were created but rarely caught or fixed. The UID Registry process will catch those duplicates and cause the part to be pulled back and re-serialized. Another potential problem is if the original Part Number cannot be determined for a legacy part, the current Part Number may be used at the time of marking, but it will be called the original Part Number because that is what the UID Policy requires. This may not be a problem since the Current Part Number is essentially the only part number ever used in operational environments, so the Original Part Number is an extraneous piece of information for all practical purposes. Therefore, when using Construct 2, assumptions cannot be made as to whether you are dealing with a new or legacy part based upon the “Original Part Number”. Figure 3-10 summarizes the business rules for UID construction.

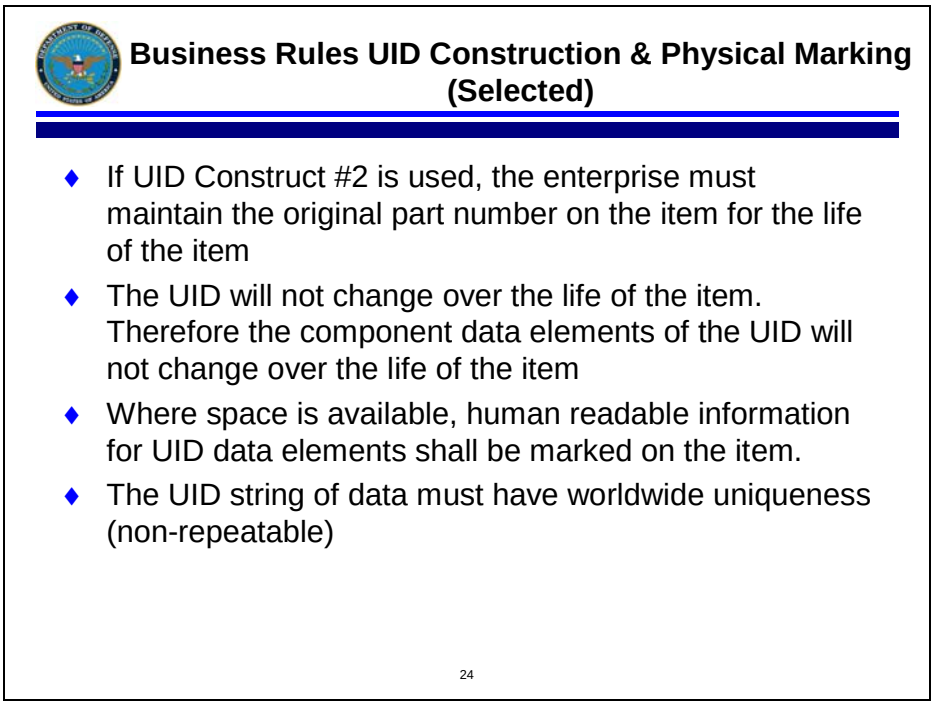

Figure 3-10

Another potential problem with Construct 2 is that two data elements marked on the part will say "Part Number" – one will be the original and the other the current Part Number. Extra training will be required to insure that the correct Part Number goes into the correct database location to avoid the mistakes that those subtleties can cause. In safety critical operations, the chance for possible confusion of the correct part number may be an issue, and a new ruling is currently being considered by the regulatory agencies.

The second approach, re-serializing legacy parts to Construct 1 when they are UID-marked, also has some potential problems. Having duplicate Serial Numbers will not be a problem (because your new process does a simple check to insure the Serial Number is unique within the Enterprise Identifier before assigning), but re-serialization requires a separate look-up table to map the new UID Construct 1 Serial Number to the older serial number to not lose historical traceability of the part. If historical traceability is not pertinent, then re-serialization may be the best choice to simplify and make a clean break with the past.

If re-serialization is the preferred choice, the structure of the look-up table would be helpful if it were commonly defined so that others in the weapon system sustainment value chain can use the same table to map to their pedigree data to the unique part under consideration.. This process has been successfully executed for the past 4 years by the Boeing CH-47 Helicopter group (and other companies) with their Opportunistic Part Marking (OPM) program. In many cases the historical data on serialized parts is so poor or inconsistent that the opportunity to start fresh with consistent, accurate UID data is the best hope they have had in decades

to re-gain control of their data. The only known standard for this is found in Spec 2000, Chapter 9, Section 9-6, describing the aerospace industry's Traceability Standard. This standard provides the linkage between the original Serial Number the part has born with many years ago, and the new UID-unique Serial Number that it will go forward with. An example from this re-serialization section of that standard is shown in Figure 3-11:

Minimum Traceability Standard | **Particular to Action Code** | **Data You Want**

Social Security #

none req'd for a new manufactured part

CAGE Code	Unique Serial #	Current Part #	Action Date	Action Company	Action Code	OEM Name	Original Serial #	Cond. Code	Your Part #	Other Data, etc.
61G49	1234567	P7DTR26	20020420	81979	**MRK**	Collins	1234567	SRV	P7DTR26	

Figure 3-11

This approach would be used when a legacy part is UID-marked and re-serialized according to Construct 1. A depot may consider adopting this Spec 2000 standard as it meets many of the Serial Number Tracking (SNT) and Serialized Item Management (SIM) needs of the future, as well as the UID re-serialization requirement currently imposed.

Despite all the focus on UID parts, a complicating factor in creating a new system is that all the parts that need to be ordered, tracked, installed, removed, and repaired are not going to be UID-marked parts. So the new process has to adapt to three classes of parts:

1) non-serialized (EID and Part Number)
2) serialized but non-UID (EID, Serial #, or EID, Part #, and Serial #)
    a. but probably never UID bar coded
3) UID-Serialized and bar coded parts (>$5000)

The existing AIS should be appropriately handling classes 1 and 2 currently, so there may only be the need to add new software modules to each application to request, compute, send, or save the necessary UID data. Unique Serial Number assignment and automatic marking machine control are typically the new paradigms for depots, and maybe the 'bolt-on' approach can mitigate those aspect of the depot UID/SIM AIS without overhauling the whole system.

The need to think broadly about this UID serialization problem cannot be over emphasized. The specific caution is that depot not make up rules and processes that work well for its needs, but break the systems that your other stakeholders use, particularly stakeholders in the field. Holistic thinking about the end-to-end effects of the UID business rules needs to be pursued in order that UID may be successfully implemented throughout the defense enterprise. UID represents a transformational change, and the depots' UID/SIM AIS design thinking must reflect that new paradigm.

Further guidance can be found in the *DoD Guide to Uniquely Identifying Items-Assuring Valuation, Accountability and Control of Government Property* (current version 1.4 published 16 April, 2004) issued by the Office of the Principal Deputy Under Secretary of Defense (Acquisition, Technology & Logistics). Important changes have occurred since the original document was published; a corrected and updated version is expected by June 2005.

New Process Definitions

The quality of the solution to a process challenge is directly related to the quality of the challenge. If the only challenge is how to get a UID mark on a legacy part, then the solution is relatively simple. If the challenge is, "How can we capitalize on UID to improve our operations, better support the weapon system sustainment infrastructure, and contribute to Defense Transformation?", then the answer will be a lot different. The depot represents a common denominator for many of the tangible assets which qualify for UID. As such, the depot may want to reconsider it's traditional "MRO" role in the life cycle of repairable assets. Perhaps the depot should become more of a "sustainment integrator" for the items for which it is the prime DOP. This approach might lend a fresh perspective to the UID decisions about to be made, and heightened concern for all the warfighters and sustainment stakeholders who will benefit, or suffer as a consequence.

Part Marking Control

It was previously discussed how important controlling unique Serial Numbers is in the overall process. Related to that issue, and possibly an entirely new concern for the depot, is how to get those unique, controlled Serial numbers into the marking machines on the production floor. The hand-marking processes of the past are not acceptable in this new UID world. UID policy demands, at a minimum, that a 2D Data Matrix bar code be applied to the part, which can only be accomplished via machine control.

The AIS/Database WIPT needs to consider whether the current system and database can support this process, and then design solutions for getting the data transferred from the AIS to the marking machines. Though not forbidden to do so manually, the clear assumption is that the UII data elements will move from the AIS to the automated marking machines without human intervention. An earlier section of this Plan describes the various marking technologies available for En-

gineering to choose from, and the AIS/database WIPT needs to work with the Production WIPT to figure out how to make everything work. The options are similar to those discussed about the AIS itself: new, "bolt-on" (see Figure 3-7), or modification to the existing AIS, but additional marking choices may also fit into a given depot's operations:

1) insert automated marking equipment in the existing production flow
2) at the appropriate spot, route parts off the production line, into a Marking Center, and back to the production line
3) if cycle times are not critical, the part marking may be outsourced for marking

Whatever the correct answer is for a particular depot, sending the correct data to the marking machines, and verifying the data that got marked on the part, are two universal aspects that need to be designed into the UID/SIM AIS. For a limited set of marking machines, the vendors' technical sales representative can assist in interfacing between the AIS and their equipment. If broader solutions are needed to cover a variety of marking equipment, two system integrators have been in the UID game the longest, ID Integration (www.id-integration.com) and Monode Marking (www.monode.com). Other UID AIS integrators are appearing every month. The UID system integrators can handle everything from installing production floor marking equipment from a variety of vendors, to portable marking carts, and mobile marking trailers that are self-contained and be moved to the job site. System integrators can handle both the hardware and software needs of the depot as well as provide training for the staff. UID implementation references should of course be requested and checked, as not every company has the same level of experience or success.

Many other technical details need to be considered – data transfer methods, wired, wireless, Sneakernet to a standalone controller, real time, asynchronous, feedback loops, quality assurance records, using the bar code in downstream production processes, etc. – that the AIS/database WIPT will need to address. There are dozens of consultants who are UID-knowledgeable and available to help with those details.

The recommendation, again, is to first consider how this automated marking will be accomplished in the depot for new manufactured parts, and only later to deal with the wide variety of legacy parts that will involve more complex decisions related to frequency, different process routings depending upon the trigger event (e.g., repair, transfer, recapitalization, reset), etc. Part marking of new parts is a much easier process (known schedule, known material, clean surface, etc.) than the less structured nature of legacy part marking. This is especially true if legacy parts require a Direct Part Mark (DPM) solution where the setup time (part clean-up, special holding jigs, power settings, etc.) may be 100 times longer than the marking process itself.

What Data Is Marked on the Part?

There are dozens of different UID format options that can get marked on the part. These encompass two different constructs (1 & 2), new and legacy part marking options, across three main data format schemas (TEIs, DIs, AIs), with additional options for marking very small parts with a concatenated UII data element. The array of options is displayed and discussed in the ***DoD Guide to Uniquely Identifying Items*** and will not be repeated here, but two examples will be presented to explain the logic how the UIIs get marked on the part and how they get converted into the actual 78 character, UII found in the UID Registry database.

A primary requirement of the UID Policy is that a two dimensional (2D) Data Matrix bar code, formatted according to ISO 15434, be applied to every part as a minimum. In addition, human readable characters (HRI) are required if space is available, and if enough space is available the addition of 1D bar codes like Code 128 symbology is allowed to ease the transition to full UID operating capability. In the 2D bar codes only, ISO 15434 requires several pieces to be assembled into a single data string and passed to the Data Matrix bar code marking equipment to encode properly. The equipment may be a thermal transfer bar code printer, a data plate-marking laser, or s DPM laser etch, dot peen, or inkjet device (or other technology)

These are the different pieces of the data string needed to mark the part:

1) ISO 15434 header information consisting of 3 printable characters: [ ) >
2) Record Separator character (unprintable) designated $^{R}/_{S}$ before every Format Code
3) Format Code, with the choices being:
   - 05 if the following data uses Application Identifier (AI) formats

   - 06 if the following data use MH10.8 Data Identifier (DI) formats

   - DD if the following data uses Spec 2000 Text Element Identifiers (TEI) formats

4) Group Separator character (unprintable) designated $^{G}/_{S}$ before the data
5) Enterprise Identifier (EID)
6) Group Separator character (unprintable) designated $^{G}/_{S}$ before the data
7) Unique Serial Number (SER)
8) Record Separator character (unprintable) designated $^{R}/_{S}$ ending the Format Code
9) End of Transmission character (unprintable) designated $_{EOT}$

Example 1: Use TEIs (Format Code DD) in a Construct 1 format

The complete data string is as follows:

> Note: underscore character (_) is only shown to indicate a "space" character

EID = a CAGE Code of 05CVA ; TEI = MFR_

Unique Serial Number = 5678950 ; TEI = SER_

[ ) > $^{R}/_{S}$ DD $^{G}/_{S}$ MFR 05CVA $^{G}/_{S}$ SER 5678950 $^{R}/_{S}$ EOT

The Data Matrix marking equipment takes that data string, both printable and unprintable characters, applies its esoteric calculations to add redundancy, error correction characters, and other "overhead", and instructs the marking machine how to place the dots in the 2D Data Matrix symbol marked on the part.

Example 2: Use DIs (Format Code 06) in a Construct 2 format

The complete data string is as follows:

EID = a DUN & Bradstreet Number of 194532636 ; DI = 12V

Original Part Number = 1234 ; DI = 1P

Serial Number = 786950 ; DI = S

[ ) > $^{R}/_{S}$ 06 $^{G}/_{S}$ 12V194532636 $^{G}/_{S}$ 1P1234 $^{G}/_{S}$ S786950 $^{R}/_{S}$ EOT

Again, the Data Matrix marking equipment does its magic and instructs the marking machine how to place the dots in the 2D Data Matrix symbol marked on the part.

Creating the Actual UID Number Data String

The actual UII in the UID Registry database is created by the application software from the Unique Item Identifier data elements marked on the part, as above. The process involves the following steps:

1) Determine which Format Code (05, 06, or DD) defines the incoming data string
2) Determine the data tag that defines the Enterprise Identifier and look up the corresponding Issuing Agency Code (IAC) for that Enterprise. The primary choices are:

Issuing Agency Code	Issuing Agency	Enterprise Identifier
0 - 9	EAN-International	EAN.UCC
LB	Telcordia Technologies, Inc	ANSI T1.220
UN	Dun & Bradstreet	DUNS
D	Allied Committee 135	CAGE
LH	European Health Industry Business Communications Council	EHIBCC

Table 3. Issuing Agency Codes

3) A. For **Construct** 1, strip off the AI, DI, or TEI data tags and extract:
   a. The Enterprise Identifier (e.g., CAGE Code of 05CVA)
   b. The unique Serial Number within the Enterprise (e.g., 5678950)

The entire UID Number is built from the IAC+EID+Serial Number as follows:

D05CVA5678950 = UII

3) B. For **Construct 2**, strip off the AI, DI, or TEI data tags and extract:
   a. The Enterprise Identifier (e.g., D&B Number of 194532636)
   b. The Original Part Number (e.g., 1234)
   c. The Serial Number (e.g., 786950)

The entire UID Number is built from the IAC+EID+Original Part Number+Serial Number as follows:

UN194532636 1234786950 = UII

Figure 3-12 summarizes the process:

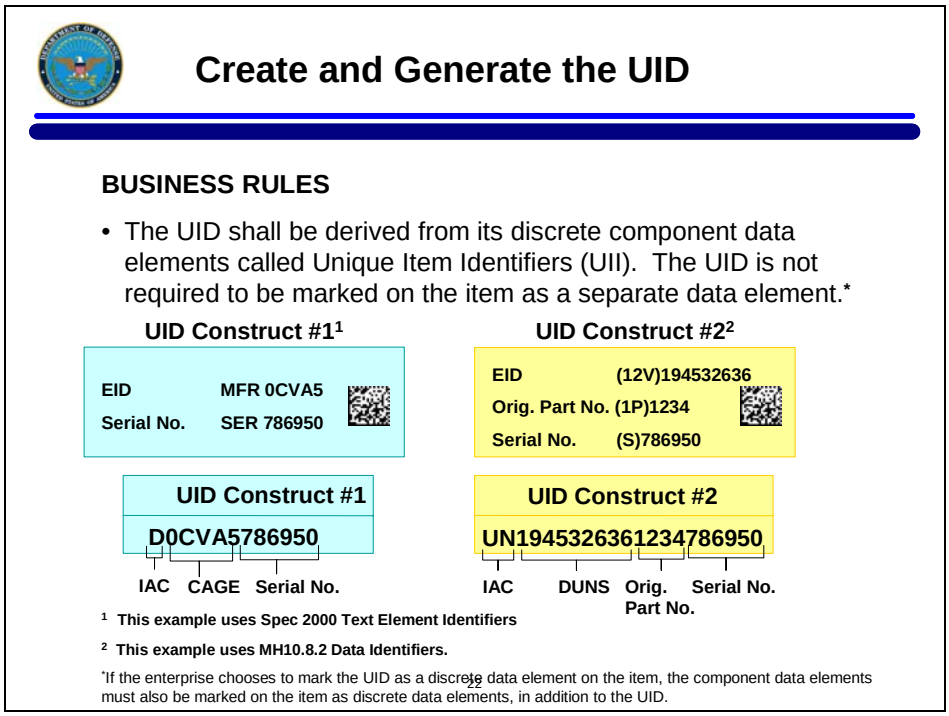

Figure 3-12

The UII data elements are the generic name for the common data that normal people work with – Enterprise ID (like CAGE Code), Serial Number, and Original Part Number. Though never used in the construct of the actual UII, the Current Part Number is a very important piece of data to include on every part. Without it, a mechanic or logistics person could only determine which Part Number he had in his hand by entering all the data into a computer system and having it create and look up the UII and respond with the Current Part Number. If the Current Part Number changes with future modifications to the part, it is preferred that the Current Part Number be marked in a separate 2D bar code that allows it to change without disrupting the primary UII data.

The lengths allowed for each of these data elements and the overall UII is specified in UID Business Rule 18 (see *DoD Guide to Uniquely Identifying Items* found on the UID web site: www.acq.osd.mil/dpap/UID/ , Items of Interest,

Unique Identification, Policy, Regulations & Standards, Guides), and is shown below:

Business Rule #18: The UID is a non-parsable field, not to exceed 78 characters in length. Overhead characters, such as syntax and data qualifiers, are eliminated from the string when the UID is constructed.

- The IAC string of characters will not exceed 3 characters
- The enterprise identifier string of characters will not exceed 13 characters, excluding the data qualifier.
- The original part number string of characters (including special characters) will not exceed 32 characters, excluding the data qualifier.
- The serial number string of characters (including special characters) will not exceed 30 characters, excluding the data qualifier.
- The sum of the maximum number of characters for possible UID data elements is 78. The use of shorter field lengths is encouraged for part and/or serial numbers where feasible.

More detailed information on the IAC lookup table, and variations on the UID number build process, can be found in the ***Guide*** mentioned above and will not be repeated here.

Overall AIS Interface Issues

To regain perspective of where the UID/SIM AIS/database WIPT is involved, the overall AIS/database design must accommodate:

1) controlling the uniqueness of the Serial Number
2) interfacing the AIS to the automated part marking equipment
3) building the UID Number correctly when manufacturing or repairing a part
4) reading other UII data elements from vendor parts to create a “parent” UII
5) verification of the data and quality of the 2D bar code mark
6) Maintaining data quality and use of XML
7) transmitting UID data and other item “pedigree” data externally to other systems

Items 1 – 3 have been discussed already, so a brief discussion of the others is in order.

Creating the UII is not a difficult process. The depot UID/SIM AIS application will do it and store the number in the database for newly manufactured and repaired parts. The other instance where the system needs to build the UII is when it is reading in UII data elements off another, existing, UID-marked part. The full UID Number itself is rarely marked on the part, but the individual UII data elements are marked in the 2D bar code.

Building the UID Number can be accomplished in one of two places: in the AIT Imager (bar code scanner) or in a computational part of the AIS system (PC terminal, server, or host computer). Though most recent 2D imagers have the capability to parse the incoming UII data elements, provide a lookup table mapping process for the IAC, and build the entire concatenated UID Number, it is recommended that, in most situations, this is a poor location to install that functionality. Depending upon the client/server design of the depots' system, the UID build functionality is much better accomplished in software rather than the reader hardware.

Because of the harsh production and field environments that DoD 2D imagers will likely encounter, the ideal system design trade off would be to use the least expensive (and least capable) 2D imagers that work reliably, and retain all the necessary intelligence in the software side on a computer. The market price for these capable 2D imagers that read Direct Part Marks is currently in the $2000 - $3000 range. This is an expensive tool to place in all the locations where they will be needed. It is more cost effective to keep the intelligence in software, as centrally located as possible in a distributed network, so that version control and software maintenance is more easily accomplished.

The other problem with putting too much intelligence and functionality in the 2D imager is if new format options are added to the UID mix, all those imagers need to be located and firmware upgrades conducted on each one. With sophisticated imagers and sophisticated IT processes in place, this might be accomplished in an automated fashion via the network. The more typical depot process, however, would be to find each imager, take it out of service, bring it into the lab to upgrade the firmware, test it, and physically return it to its factory location. Software maintenance and control on portable and peripheral devices is extremely difficult, costly, and time-consuming, as any Tech Support person can tell you about laptops, Blackberries, Palm Pilots and other intelligent, peripheral devices.

Data Matrix Quality Verification

Verification of the quality of the 2D Data Matrix symbol is currently a hot topic across the industry. The minimum requirement in the UID Policy is for UII data to be encoded in a Data Matrix symbol. If that symbol is difficult to read, the foundation of UID becomes shaky, so insuring a high quality 2D symbol is important. For gummed label and most data plate solutions, the existing quality standard (ISO 15415/ISO 16022) is considered adequate. The marks and the standards are tuned for high contrast, black-on-white marks. The problems come

with most forms of Direct Part Marks (DPM) – dot peen, laser etch, laser bonding, electro-chem-etch, inkjet, etc. – these marks can best be described as grey-on-grey, with the contrast between an "on" dot and an "off" dot being difficult to distinguish.

The UID Policy references MIL-STD-130 as the guiding document, and MIL-STD-130 requires a 'B' grade quality mark on all parts, using ISO 15415 as the standard. Unfortunately, few if any parts marked with DPM technologies would ever meet the 'B' grade standard. This deficiency is widely acknowledged, and significant resources from the military, the technology providers, the standards organizations, and UID equipment suppliers are being applied to resolve that issue quickly and modify the ISO 15415 standard. A new quality recommendation is expected as early as June, 2005. It remains unclear at what point the MIL-STD-130 owners will feel comfortable adopting the recommendation.

The pragmatic recommendation regarding verification of the UII data and the quality of the Data Matrix symbol is for the UID/SIM AIS/database WIPT to plan ahead for it and include it as a significant feature in the new process that will be created at the depot. Typically, immediately after a Data Matrix symbol is applied to the part, a 2D verification imager, vision system, or other process (e.g., AS 9132) would be used to verify, and possibly record, the accuracy of the data and the quality of the symbol. The accuracy of the data in the mark, versus what was intended, is extremely important and can be implemented without the quality standard being finalized. If the data (e.g., Serial Number) happens to be incorrect, the mark would need to be removed and re-applied. With labels or data plates this is merely inconvenient; with DPM it becomes quite costly and time consuming – but very necessary! The UID policy provides no specific guidelines about what happens if the MIL-STD requirements are not met, but commercial suppliers plan on storing the verification results in the AIS as proof that they met the requirement. The 2D Data Matrix symbol is such a key piece of the DoD's Transformation efforts across many different systems that proving the quality of the UID mark is expected to be a high priority.

Data Integrity and XML

Another consideration in the overall UID/SIM AIS design relates to the integrity of the data. This has several aspects to it. It involves not just the accuracy of the data, but using it appropriately by avoiding confusion about what it means and how it should be applied. It is analogous to having a smart bomb that, dropped from 50,000 feet, is so accurate it can go right down a smoke stack of a factory, versus insuring that the correct smokestack is designated in the first place.

Data integrity is typically fairly poor. 95% accuracy looks pretty good on the surface, until we consider the confusion and delays that other 5% costs. The ratio is probably just the inverse of the accuracy: the 5% of the data (part numbers, serial numbers, purchase orders, quantities, delivery points, etc.) that is incorrect consumes 95% of our time to find the mistake and fix it! Mistakes in the data is very

costly. First is the problem knowing there is a mistake, and how far from the source is that mistake found. That is the easier part of the problem: an incorrect Part Number will not be delivered because the Supplier has no inventory item with that Part Number. The more difficult aspect of the problem is knowing what the correct data is, and the further from the source the incorrect data gets, the more difficult and costly it is to determine what the right information was supposed to be.

The UID Policy has addressed a major source of data errors by requiring the use of Automated Information Technology in the form of 2D Data Matrix bar codes. This will mitigate one aspect of the data accuracy problem: that associated with transferring data accurately from the physical world into the computer world. While a well-trained touch typist makes an error once every 300 characters, the Data Matrix bar code symbol allows an error approximately once in every 300 million characters. The Data Matrix symbol itself will either deliver accurate data, or no data at all, but it will not give you bad data. Theoretically, this solves the problem of typographical mistakes that humans make all the time – but it only solves it if there is a 2D imager at every location where data is being transferred, and if the 2D imager is working correctly (optics, electronics, user training, etc.). These are important UID issues unrelated to technology. Technology, no matter how wonderful, must be implemented correctly to deliver the desired results.

Once the data is transferred accurately from the physical world into the digital world, the quality of the data then becomes an issue. For example: The Part Number being ordered is accurate, but is that a National Stock Number, a Joint Strike Fighter Part Number, or the Manufacturer's Part Number? If the AIS and database allow one column to store the Part Number, whose Part Number goes in there? Is there an edit check on that data entry at the source so that incorrect data (but still very accurate!) cannot be entered into the system? This is where the confusion starts, and it is also the best place to make the confusion to stop.

The above problem is the easy one to solve – problems like this can be fixed and avoided by competent programmers in a single AIS instance. But what happens when that data is passed off to another application or database within that same AIS, to a different AIS, or outside the organization to a remote stakeholder? The real meaning of the data is easily lost. As we have historically done a fairly good job of not losing parts as they flow through the physical supply chain, we now need to understand that the data <u>about the part</u> also has a "supply chain", and it moves much faster and further than the physical supply chain. Because of that, it is becoming increasingly important that data quality (correct meaning) as well as data accuracy be maintained.

How is that accomplished when data flows into disparate databases beyond the depots' control? In the near term, it will continue to require a very manual, labor-intensive communication effort to insure that any data passed to other decision support systems is correctly understood on the other side. In the longer term, this problem is addressed by the use of XML-tagged data, where common definitions

are defined and understood for the various kinds of data – the "part number" situation from above is the classic example. With XML, the data intelligence is carried with the data in the data tag, so that no application or database has to guess which "part number" is being referenced. The DoD has an XML Policy which should be addressed as depot UID/SIM AISs are being configured. Continued communication about XML standards is needed to insure that all parties are moving in the same direction.

Ubiquitous XML usage is not going to happen across DoD databases and supply chains in the next decade, and yet the UID/SIM AIS/database WIPT has a unique opportunity to start heading in the correct direction. XML tags on the data can be applied after the fact, when the data is in a database or when it is transferred to another AIS/database. Even better is for the source data, gathered from the physical world, to be XML-tagged from the start. The UID Policy has required "tagged" data (but not XML-tagged data) in the 2D bar code using either AIs, DIs or TEIs, which is a significant start because it is a move toward intelligent data marked on the parts, rather than just the naked numbers of the past. Fortunately, one of those formats, Spec 2000 TEIs, qualify as XML compatible (because they begin with alpha characters, are "well formed and self describing"). It would be good for the depots to begin aligning their thinking, their applications, and their databases along XML lines so that, when a comprehensive XML policy is established, depot UID/SIM systems are able to accommodate it.

UID PRODUCTION INTEGRATION WIPT

The Production WIPT is comprised of individuals representing the industrial engineers, supervisors, and workers who have the difficult task of making all this function in the real world. In the depot, the "rubber meets the road" at the point of production. All plans, schedules, computer applications, equipment installations, and process interfaces need to work correctly so that the depot can create and deliver expected products and services. Lack of planning or execution on someone else's part may not show up until the production floor – so the Production WIPT has a vested interest in making sure the other two WIPTs have done a good job!

The changes demanded by OSD's new UID policies will have a primary impact on Production. Not only will UID cause changes in their processes as parts need to be marked and read in ways that never happened before, but there is also the cultural changes that need to occur to make UID implementation a success - things like the introduction of and training for computerized marking equipment and computer data entry where there may not have even been a computer in the area in the past. The UID Production WIPT will need to be very involved in a collaborative mode with the Engineering WIPT and the AIS/database WIPT so that all conference room planning is continuously subjected to a reality check.

The recommendation is to plan first for marking the depots' newly manufactured items (being the simpler case), and then go back and apply the same logic to the larger, but relatively unscheduled, body of legacy parts that will flow through the depot for repair.

The Production WIPT has two major tasks associated with UID Implementation, but each one has deep and broad implications for 'business as usual':

Insert Part Marking, Reading, and QA into the Production Process

In collaboration with the Engineering WIPT, which has the responsibility for selecting the appropriate marking technology for a given part, the Production WIPT should decide where in the manufacturing/repair process the UID marking should occur. Should the parts be marked real time in the production flow, or should they be marked offline in a dedicated marking center and brought back to the production line later? What job instructions, process changes, and training needs to be accomplished for either to happen?

Because the UID requirements include tracking and reporting which UID parts are attached to/imbedded in other UID parts, it is very likely that interfaces between the AIS and the production process will need to be created for the first time, or changed and improved, to meet this goal. It is possible that the depot production process can continue as before, with data being collected on paper forms and entered into the computer at a later time -- it is just unlikely that the data will ever be accurate enough to meet the valuation, audit, and accountability requirements that precipitated the entire UID initiative in the first place, and manual data management will certainly not be adequate to deal with the workload volume associated with wholesale legacy parts marking.

If computer technology is not currently a part of the existing process, what are the physical and cultural changes needed to re-engineer the process? Inserting computer technology into a non-computerized production environment is not an easy undertaking – enormous changes need to be skillfully managed so that depot effectiveness is not put at risk.

With the UII already marked on the part, it only makes sense to include the 2D imagers needed further down the production line (and/or sustainment value stream) to take advantage of the data that is already in digital form. All the data is tagged and intelligent so the UID/SIM AIS can read all the data with one beep of the bar code imager, and then parse the data by CAGE Code, Serial Number, Part Number, etc. to display, in the correct data fields on the screen, the pedigree information of interest. This process should certainly be done for building Composition Database (Part # and UID Number of the 'As-Built' final product). The 2D bar code reading should also be done immediately after part marking to insure that a) the data is correct, and b) the quality of the bar code symbol meets MIL-STD-130 requirements. It is recommended that this data be retained as historical proof of the original quality of the mark. And after years of operational service it

will also be instructional to understand if, or how, the quality of the mark degrades with use, repair process, etc. so that a more permanent, durable mark can be applied on the next generation of parts.

An important, perhaps difficult, task will be for the Production WIPT to help the PMO/Depot IPT quantify the benefits that will accrue to the depot from all these changes. WIIFM – "What's In It For Me" – is always the unspoken question whenever someone is being asked to change how they do their work. And it is a question that deserves an answer – whatever that answer is deemed to be. There are two areas to explore to answer the WIIFM question:

1) Can you make the production job easier, removing some of the frustrating parts of the job?
2) Can you provide useful information back to the people who are being asked to enter the raw data in the first place? This is the Feedback Principal.

Depot operations range the gamut from poorly automated to fully automated, so the Production WIPT may want to consider some or all of the following WIIFM ideas:

a) Speed the process of determining the status or whereabouts of a repair part
b) Make the above status process widely and easily accessible
c) Put paper documents online to aid in easy retrieval
d) Provide easy search/pulldown menus for non-typists
e) Strive to make the computer screens as simple as possible, versus as exhaustively complete as possible
f) Allow documents to be easily printed for taking to where the job needs to be accomplished (usually not next to a computer terminal)
g) Allow expendable parts (nuts, bolts, washers, etc.) to be easily located in other areas and/or easily re-ordered if depleted
h) Use portable, handheld terminals to send/receive data when the job or information is not near the computer terminal
i) Use AutoID technology (typically, bar code) to avoid having to key data into the keyboard (not a strength for most production workers)
j) Use temporary "production tags" in bar code/RFID formats to track parts until they get to Next Higher Assembly installation
k) Avoid writing data on paper and re-typing into computers; collect as much data at the source in digital form as possible
l) Don't make workers re-enter any data (unless for verification) that already exists in a database
m) Use the UII data elements bar coded on UID parts as much as possible to identify, track and log where the part is

n) Provide pertinent production data back to workers so they understand how they are doing as a person/work center, and what part they play in the entire process of meeting production goals
o) Utilize a "dashboard" concept of simple graphics to display data summaries
p) Never use more/better information against a worker or you will automatically get less/worse information from the entire operation for years to come – the 'penny wise/pound foolish' syndrome
q) Plan on regular re-training opportunities as people cannot absorb all there is to understand in one or two attempts

The effort of technology insertion into a mature MRO process is a complex task: paying attention to change management issues such as the WIIFM question during the design and implementation phase will dramatically increase the chance of success.

Improve the Production Process Using UID Data

There is a constant pressure for the depot to be better-faster-cheaper in how they do their work. The significant changes initiated by the UID Policy, and continued with the Serial Number Tracking and Serialized Item Management initiatives, allow a fresh opportunity to discover investment resources for efficiency and productivity improvements. Eliminating non-value added work from a process and making the status of jobs and the location of parts more visible to the average worker can have huge impacts on depot cycle times, dropping them (and associated costs) by 25% or more.

Whether the depot is focused on new manufactured parts, repair process, or both, the Production WIPT should use the occasion of UID implementation to re-think and redesign depot processes to squeeze out waste. Six Sigma (http://www.isixsigma.com), Theory of Constraints (www.goldratt.com), Lean Manufacturing(www.lean.org), or War on Waste (www.thewaronwaste.com) principles and resources are available to help.

POPULATING THE UID REGISTRY

Physically applying the UID mark to a manufactured or repaired item and recording required UID data represents a formidable technical and change management challenge within DoD's depots. However, there is an accompanying administrative responsibility that may be equally challenging, especially as the depots get deeper into marking legacy items. When decoded, the 2D UID matrix reveals very little about the part (enterprise identifier and serial number [UID

Construct 1] or enterprise identifier, serial number, original part number and current part number [UID Construct 2]). All other attributes of the marked part, both required and discretionary, need to be compiled, recorded and transacted to a remote data base.

Associating Unique Item Information with UID Mark

The clearest explanation available for these UID Registry data submissions are found on the main UID web site (http://www.acq.osd.mil/dpap/UID/) . There are also a number of web, email, and phone resources listed on this web site to aid the user in the submission process which vary from one-at-a-time web-based submissions, to File Transfer Protocol, to XML-formatted files submitted via DEBX/GEX servers, to batch file submission processes. The body of practical knowledge and experience on this process is not yet extensive, but that should be changing in the months ahead. Future revisions to this Plan will document user experiences and suggest preferred alternatives.

For convenience, the crux of the data submission process, including the necessary UII data elements, is shown below, but the UID web site will provide a broader cross reference to other resources:

Unique Identification of Tangible Items

Data Submission Information

1. Who is responsible for submitting UID data?

After January 1, 2004, requests for proposals (RFPs) will include DFARS clause 252.211-7003, Item Identification and Valuation, and a reference to the most current version of MIL-STD-130. Contracting officers shall include the DFARS clause in all solicitations and contracts that require delivery of items that meet UID criteria. Program managers will identify any other items requiring unique identification. The prime contractor has the responsibility to furnish Unique Item Identifiers (UIIs) or other DoD recognized unique identification equivalents, and to provide the Government's unit acquisition cost of items that are delivered to the Department under a DoD contract. UID data should be submitted with the shipment notification.

2. What data is required?

Data requirements for UID data are based on the DFARS Interim Rule on "Unique Item Identification and Valuation" which was published in the Federal Register on October 10, 2003 (DFARS Case 2003-D081) or subsequent revisions.

In order to capture UID Item Pedigree, the following core UID data elements are required:

- UID Type
- UID

Based on the UID type, one or more of the following elements may be required:

- Issuing Agency Code
- Enterprise Identification Number
- Original Part Number (not required if using UID construct # 1)

- Current Part Number
- Serial Number

In addition to these elements, the following acquisition data elements are required:

- Contractor CAGE or DUNS number
- Contract Number
- CLIN/SLIN/ELIN
- Item Description
- Foreign Currency
- Unit of Measure
- Acquisition Cost
- Acceptance Location Code
- Shipment/Acceptance Date
- Ship To Code

Please see the UID Elements Structure document for details on data format. (http://www.acq.osd.mil/dpap/Docs/uid/ElementsStructureV2.0uid.pdf)

Initial constraints for UID data submission include:

- Submit UID data and unit acquisition cost related to fixed price and cost-type contracts via WAWF if vendor and government stakeholders are set up in WAWF.
- Provide for end items only. The process for reporting embedded items is under development.
- Refer to the "Guidelines for the Virtual Unique Item Identifier (UII)" dated December 29, 2004 on the website at http://www.acq.osd.mil/dpap/UID/policy.htm for the most current guidance for submission of virtual UIIs.
- The process for reporting unit acquisition cost only, for items not requiring UID, is under development.

For the most current guidance, please reference the UID website at http://www.acq.osd.mil/dpap/UID/.

3. When is data required?

When a contractor ships items, UID data must be included in the electronic shipment notification as the contract specifies and as the program manager requests. WAWF has been enhanced to process the UID data for fixed price and cost-type contracts. A number of solutions for direct submission have been developed to accept UID data for items that have been accepted by the Government in those cases where the vendor cannot use WAWF for UID (not all stakeholders are ready to use WAWF). See Item 6 for further discussion of the direct solutions.

4. How do I submit UID data via WAWF?

Vendors can submit invoices and receiving reports electronically into WAWF using existing Electronic Commerce methods. Choices include Web interactive forms and electronic submission from Vendor automated systems. Vendors can access the WAWF system via the web interface at https://wawf.eb.mil/ and follow the link called "Self Register to use WAWF (New Users)", where they will be walked through the process of gaining access to the WAWF system.

Government users, which include inspectors and acceptors, have the ability to review receiving reports, compare products/services to the contract terms, and accept shipments online. Improper documents can be electronically rejected back to the vendor for modification and resubmission.

Utilization of the WAWF Receiving Report (RR) and the WAWF Combo to capture the UID data is annotated in the enhanced Vendor guides. Currently, UID availability in WAWF utilizes a system parameter that permits the availability of the UID associated fields on vendor created Receiving Reports.

5. How do I submit UID data in the interim?

The interim or direct state is defined as the process of submitting UID data outside of the WAWF process. There are four methods that can be used to submit UID data directly. Electronically, data may be submitted via an X12 Ship Notice/Shipment and Billing Notice (856/857) transaction, a UID XML transaction, or a WAWF UID Receiving Report/Combo UDF. All three electronic submission methods require access to the DEBX/GEX. For existing WAWF users, these methods do not replace the current WAWF interaction but are performed in addition to it after the shipment has been accepted. Manually, data may be entered via the UID Web Entry site.

Both the X12 and UDF submission formats require adherence to the WAWF interface guides. The updated guides can be found at http://www.acq.osd.mil/dpap/UID/ and at https://wawf.eb.mil/. In addition, the Federal Implementation Convention for the 4010 856 Ship Notice/Manifest and the Department of Defense Implementation Convention for the 4010 857 Shipment and Billing Notice have been modified to include UID data and are posted on the Fed eBiz website (http://fedebiz.disa.mil/). To separate the UID X12 transactions destined for the UID Registry from other X12 transactions, the UID X12 transactions must have the Application Receiver Code (GS03) populated with the value “UIDREG”.

For the UID XML data submission method, please see the Direct Submission Information in the UID Element Structure paper and the XML Schema. Each UID XML file will be sent to a DEBX/GEX, which will pass the information on to the UID Registry

All direct file submissions must utilize the DEBX/GEX either directly or via a VAN. If an organization has an existing connection, it must contact their DEBX/GEX administrator. If there is no existing connection, complete the account setup process found at http://ec.ogden.disa.mil/ecip.htm.

The final option is to manually enter the UID data via the production UID Web Entry site. To do so, an organization must register at the production UID Registry via the website https://www.uid.bpn.gov/. Organizations that wish to explore the functionality of the UID Web Entry site in a non-production environment may access the UID Registry test site found at (updated link coming soon) . Registration is required in order to access the full functionality of the UID Registry test site.

All direct UID submissions will occur after the Government has accepted the items following current business processes.

Submission Method	Action
856/857 X12; GS03 = “UIDREG”	Use existing connection, contact DEBX/GEX administrator to coordinate X12 connection
	If no existing connection, complete account setup process at http://ec.ogden.disa.mil/ecip.htm
UID XML	Use existing connection, contact DEBX/GEX administrator to coordinate XML connection
	If no existing connection, complete account setup process at http://ec.ogden.disa.mil/ecip.htm
WAWF RR/ Combo UDF	Use of existing connection, contact DEBX/GEX administrator to coordinate connection
	If no existing connection, complete account setup process at http://ec.ogden.disa.mil/ecip.htm

Manual Web Entry	Access https://www.uid.bpn.gov/ to register for UID Registry.

6. Can I have the UID portion of a selected file format validated before using it in the production environment?

Yes, you may have the UID portion of a direct submission or end state file validated. Send an email to the Unique Identification Program Office (info@uniqueid.org). Include your name, organization, phone number, email address, and the file format you will be using

7. For the direct submission methods, will there be any status files returned that would need to be processed?

Currently, no files or acknowledgements will be returned.

8. Who can I contact for more information?

For additional information, please email any questions to the Unique

Identification Program Office via info@uniqueid.org.

The decision tree in Figure 3-14 identifies when to use WAWF and when to use a direct method.

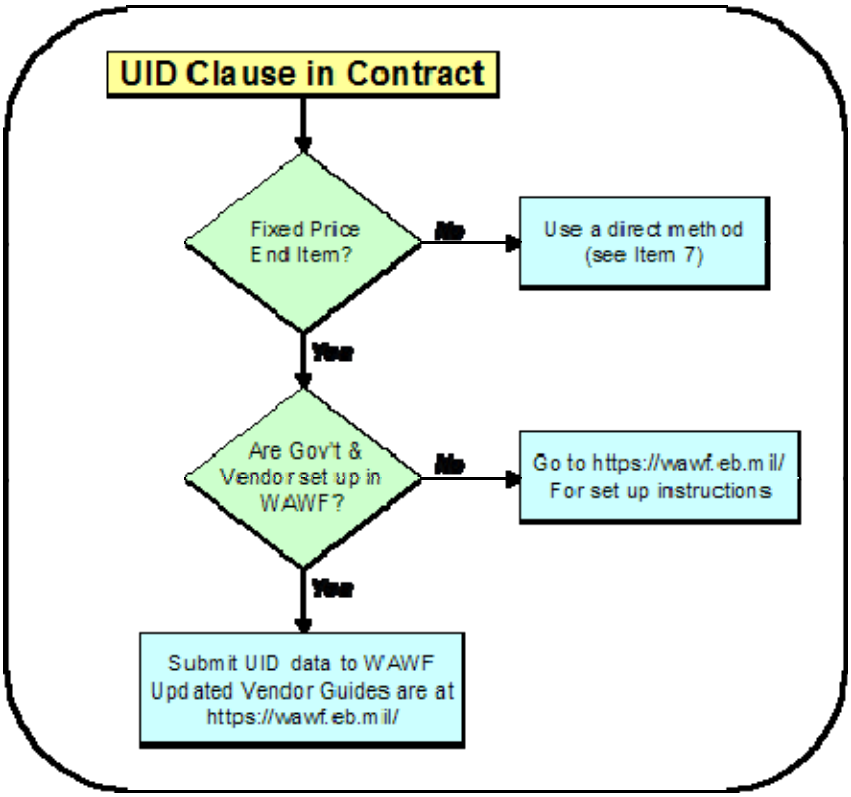

Figure 3-14

When a depot marks a legacy part and gives it a UII, it needs to transact that information to the UID Registry using the same data elements listed below in the Virtual UID section of this Plan. It is important to note that the UID Registry only defines (at this point in time) enough data elements to meet the Registry needs – not necessarily the needs of the depot in the transition into the SIM world. The key missing component that the depot will need is the linkage between the 'before' and 'after' pedigree data when the legacy part is being marked for UID compatibility, especially if a re-serialization process has occurred to move to the cleaner, Construct 1 structure.

As of this writing, there are functions of the legacy part Registry process that are neither defined nor operational. It would be premature to recommend depot data transaction business rules until Registry protocols have matured. The main UID web site (http://www.acq.osd.mil/dpap/UID/) is the authoritative source for progress in this area. As soon as legacy data transaction procedures have been finalized and tested, they will be included in this Depot Implementation Plan.

THE VIRTUAL UID CONCEPT

The Virtual UID is an approach to utilize data about serialized parts currently maintained in thousands of current, independent Service SNT databases. The strategy is to create a virtual UID record in the UID Registry without needing to physically apply a 2D Data Matrix bar code on the part itself. The intention is for some future trigger event to cause the part to be marked, linking the item with its "pedigree" record in the Registry. *Virtual UID only postpones the requirement to mark; it does not remove the requirement*. More information can be obtained from the UID web site at:

http://www.acq.osd.mil/dpap/Docs/uid/Virtual%20UII%20Guide%20ver1.0.doc

The business rules for virtual UID (VUID) qualification are very similar to the original criteria for becoming a UID item:

- Item above $5000 in historical acquisition cost
- Item is either equipment or a reparable item
- Item has an existing Serial Number, and is currently being serially managed or is particularly mission critical and needs to be serially managed

The data required to submit a VUID into the Registry is somewhat similar to the submission for a new part. The list below shows the data elements defined at this time for legacy part registration into the UID Registry, and these, at a minimum,

should be gathered by the depot UID/SIM AIS when legacy part marking is accomplished:

1. Concatenated Unique Item Identifier
2. Issuing Agency Code
3. Enterprise Identifier
4. Original Part, Lot or Batch Number
5. Current Part Number (if different from the original part number)
6. Current Part Number Effective Date
7. Serial Number
8. Description
9. Acquisition Value
10. Parent Item Virtual UII
11. Innate Serialized Data Mark
12. Innate Serialized Data Mark Contents
13. Marking Enterprise
14. Accountable Contract Number
15. Date Sent
16. Date Received

The requirement states that these data elements are mandatory for UID Registry submission; it will require a very complete to hold all this data (a blend of the initial acquisition database and a current operational database) in one place. There is the possibility that various databases could be merged to extract the necessary information, but without careful analysis of the type and accuracy of the data in each specific instance, the chance of creating faulty UID Registry data is quite high. The best opportunity for accurate data is if the legacy serialized parts do reside, and have always resided, close to where they were 'born' in a relatively closed loop system. The VUID concept means that the depot does not have the part available to mark, and careful planning will be needed to communicate to the future marking process that this part already has a Virtual UID Number assigned to it and exactly what that number is. As with the Legacy Part UID Registry data submission, the depot will probably want to keep a more thorough pedigree record for themselves than the UID Registry requires. Under the current vision, the depot is the "owner" of the part (on behalf of the Weapon System PMO, Commodity Manager or Item Manager) and has a broader, longer-standing interest in the history of the part than any other organization. The depot databases need to insure that the linkage to past data records is not lost in the transition to UID data schemas. Authority to use VUID on any particular part or piece of equipment resides with the PMO/Depot UID IPT -- this authority must be exercised judiciously.

TRACKING MARKED PARTS -- BRIDGE TO SIM

Deciding which parts to mark, changing the depot AIS and production process, and actually applying a 2D bar code to the part is just the beginning of the process. Part marking is really just a cost – there is no inherent benefit in the mark itself. The benefit comes in having a consistent, permanent data structure and identity upon which improved business functions can be built. One of these "business functions" is Product Life-Cycle Support" (PLCS) (see Figure 3-15).

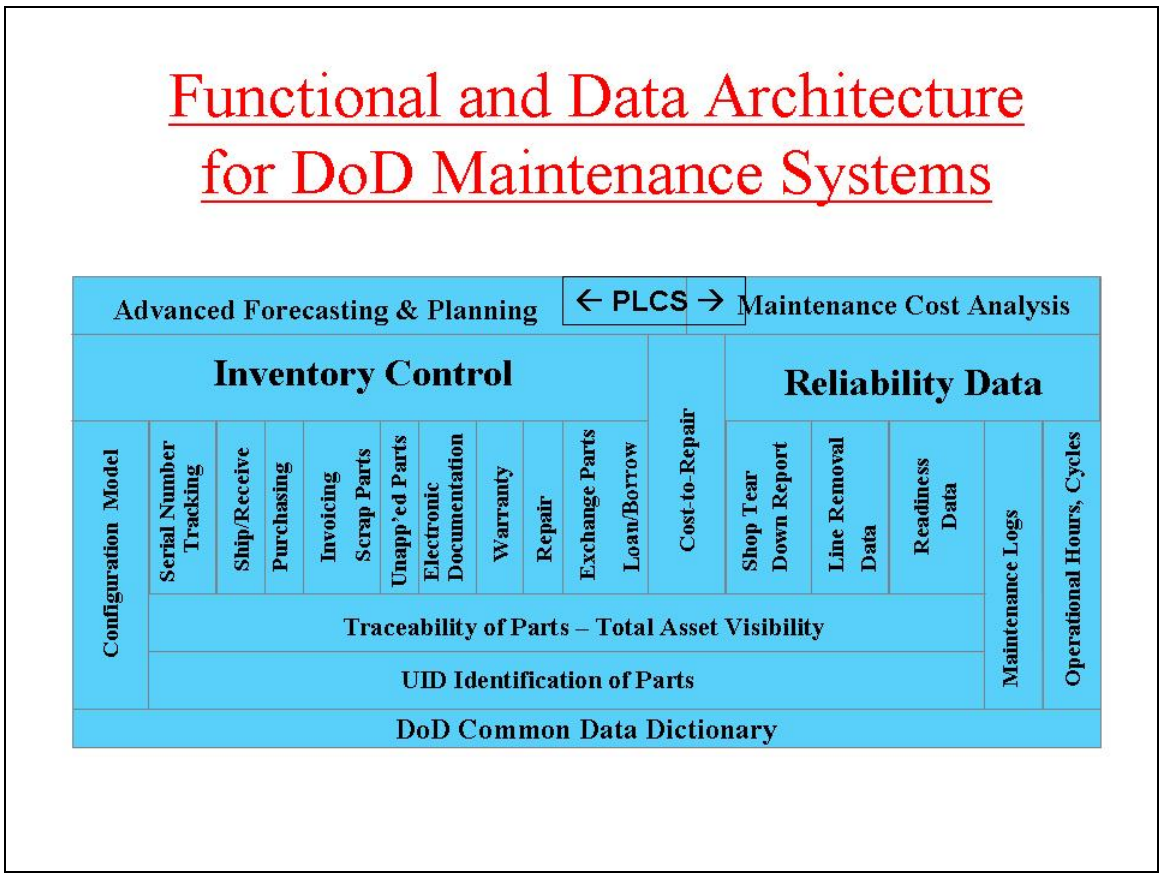

Figure 3-15

PLCS requires unique item traceability. "Traceability" means being able to record and view the life history of the part, and is similar to a resume for a person. It shows when and where a part was born, where it has been, what has happened to it, and what it has accomplished. The ability to trace the life history of unique tangible assets is achieved within the Services' SIM programs.

One initial SIM strategy would give the depot which is the primary designated overhaul point (DOP) for a DoD weapon system, equipment item or repairable part has the responsibility to maintain the SIM data base for that weapon, equipment item or part. As SIM matures, every significant event in the life of the part may potentially be recorded in the SIM data base. An example of the kinds of events or actions that might warrant a posting to the SIM data base is shown below:

Action Codes

a) MRK - Marked By (UID initialization)

b) MFG - Manufactured By

c) SHP - Shipped To

d) INS - Installed On/In

e) RMV - Removed From

f) RPR - Repaired By

g) OVH - Overhauled / Remanufactured

h) EXC - Exchanged For/With

i) SLD - Sold To

j) BUY - Bought From

k) DES - How Destroyed

l) WHR - Warehoused At

m) OTH - Other (Requires the mandatory Description data)

n) RCD - Received From

o) UPG – Upgrade, with New Part Number

p) INP - Inspected/Tested/Adjusted

q) ODO – Original Design Activity Is

r) CDO – Current Design Activity Is

Clearly, management oversight is essential to avoid an expensive (and probably unproductive) SIM data collection frenzy. This oversight will be provided, for any given weapon system or population of parts, by the successor to the PMO/Depot UID IPT (the PMO/Depot SIM IPT). A Concept of Operations for this IPT is beyond the scope of this UID Implementation Plan, but features of the vision end state cannot but help inform current planning.

With wholesale SIM operational, when a reportable trigger event occurs, an appropriate "pedigree update" will be transacted to a designated database providing, directly or indirectly, the necessary traceability for that part. For each event, a minimum amount of common, consistent data will be defined for collection every time a traceability record is written. A minimum list of seven common data elements is shown below:

Data Needed in Every Traceability Record

1) Enterprise ID (EID) of the part
2) Serial Number
3) UID Number
4) Current Part Number
5) Action company's EID
6) Action Date
7) Action Code (listed above)

The best link is of course the UID Number, but provisions need to be made for other non-UID serialized parts (e.g., those under $5000). [The third category of parts, non-serialized items, are self-removing from traceability considerations – if they have no Serial Number to individually identify themselves, then they cannot be individually tracked].

The complexity comes when the UID-marked part leaves one AIS control and enters another AIS control, possible from manufacturing cell to warehouse, from warehouse to production assembly, from the depot to a CONUS site, from a CONUS location to a field-deployed unit. Each of those AIS's will need to have a similar capability to log traceability of the part, and eventually to transmit updated pedigree information back to the master SIM data base at the DOP. This implementation concept will be dealt with more completely in a report to be published by DUSD(L&MR) in November 2005 detailing the Full Operating Capability (FOC) for I-, O-, and D-level implementation of UID as it relates to the Serial Item Management (SIM) Policy.

To accomplish such traceability, the DoD must continue to develop and document the minimum data standard each depot AIS will need to meet when UID full operating capability (FOC) is reached. Not only will each UID/SIM AIS need to store traceability data, they will also have to be able to 'dialogue' with other databases - receive pedigree data updates – and share that data with the depot and other appropriate equipment sustainment AISs. Figure 3-16 represents an overview of what a depot's UID FOC AIS capability might look like:

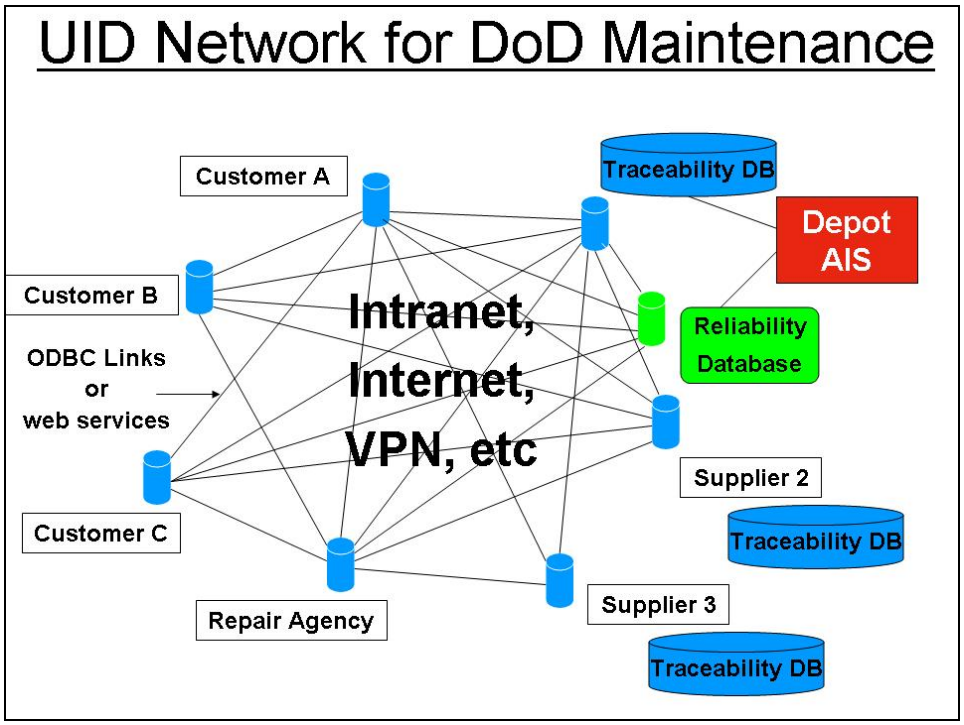

Figure 3-16

The system architecture has to remain flexible between the two extremes of 'relatively disconnected, distributed, local, systems' and 'one massive ERP system holding all the data' – neither extreme will work well in today's world. What will work are loosely-coupled, distributed systems that are constantly communicating using common data. That type of architecture provides the different functionality and response times needed at the O-Level, I-Level, and D-Level locations. It is logical that the depot who "owns" the part (i.e., the primary DOP) have the most complete traceability database, but some of the data needs to be distributed to respond to the needs of each organization. The key is defining what the common data is across all the pertinent systems and implementing the communication links to either push or pull the unique item pedigree data as appropriate. Complete traceability capabilities may not come about for many years, but the vision needs to be clear so that progress in the desired direction may be achieved and maintained.

SUMMARY

OSD policy requires DoD's depots to develop the capability to apply UIIs to the parts and equipment they manufacture and to the legacy parts and equipment currently in inventory and operational use which they repair, rework or modify. This includes the requirement to compile and record required asset "pedigree" informa-

tion specific to each part so the data may be entered into the UID Registry and associated Service Decision Support System data bases.

The foundation of the UID concept is to give expensive, serialized parts a Unique Identifier, a 'social security number', that everyone who needs to know what's happening to the part during its life-cycle can consistently and accurately get the information they want. It can be safely said that no depot is currently engaged in wholesale computerized, automated part marking and pedigree management. This is about to change, and the change will be an important contributor to Defense Transformation.

The cross-functional IPT/WIPT approach is the only one that will be successful with the type and magnitude of organizational change required. UID/SIM is particularly challenging because it touches so many aspects of the way business is currently conducted at the depots, and elsewhere. It is also difficult because it forces the computer world and the physical world to come together in ways they never had to before. That man-machine interface was much more loosely-coupled in the past - with a human typing data being the primary linkage between the two worlds. Now automated data input will be an integral part of the entire process, and the process will not move forward until the computer is "satisfied". This initiative is not without risk, but, if successful, increased computer process control will relieve people from a lot of mundane work, freeing them up to address more creative problems within the industrial MRO enterprise. It will also provide much better visibility and information up and down the chain of command so that systemic weapon system support problems occurring anywhere within the end-to-end sustainment value chain can be more quickly identified and more effectively resolved.

This plan identifies parts marking actions required, examines alternative strategies for satisfying current policy mandates and suggests preferred ways to meet the requirements, based on Service inputs.

Accomplishment of UID parts marking, UID Registry population and successful integration of UID technology with legacy financial and inventory accounting systems will produce the strategic outcomes currently envisioned for UID:

- Enhance logistics, contracting, and financial business transactions supporting U.S. and coalition troops.

- Enable DoD to consistently capture the value of items it buys, control these items during their use, reduce operating costs and combat counterfeiting of parts.

- Enable DoD to make appropriate entries into its property accountability, inventory, and financial management information systems toward achieving compliance with the Chief Financial Officers Act.

Beyond UID for improved asset tracking and financial accounting is the opportunity to profoundly improve the way DoD materiel is maintained. UID/SIM enables “pedigree management” a transformational capability which offers the weapon system sustainment community new insight into the performance of the end-to-end materiel readiness value chain, at individual item granularity. Using the accurate and timely data provided by SIM, state-of-the-art analytical tools will reveal cause-and-effect relationships between resource investments and readiness outcomes, relationships here-to-fore impossible to discern. Informed by the facts, decision makers will be in a much better position to effectively balance the distribution of resources in order to optimize materiel availability and consequent weapon system operational readiness.